# MEDICAL CARE RESEARCH AND REVIEW

Supplement to
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*Special Supplemental Issue:* **Estimating VA Treatment Costs: Methods and Applications**

Research and Supplement Supported by the VA Health Services Research and Development Service

*Guest Editors:* **Ann M. Hendricks and Douglas D. Bradham**

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MEDICAL CARE RESEARCH AND REVIEW

# Foreword

As one of the largest health care systems in the county, the Department of Veterans Affairs (VA) provides care for millions of veterans each year who have an array of health issues as diverse as the patient population. Since 1995, the number of veterans seeking VA health care services has risen 43 percent. Consequently, one of VA's major challenges is to identify the most cost-effective ways to provide quality health care during this time of unprecedented demand. This is more easily said then done in a national budgeted health care system with no billing data or co-pays from which to estimate costs. Unlike other health care systems, VA has had to determine its own unique costing methods. To assist in this endeavor, VA's Health Services Research and Development Service (HSR&D) established an economics resource center to define appropriate methods for determining costs and improving the quality of health economics research in VA.

Since 1999, HSR&D's Health Economics Resource Center (HERC) has been working to identify and refine methods for determining the costs of VA health care. This supplement is an important outcome of this work. Articles discuss the methods for determining the average costs for acute VA hospital stays for medical and surgical care, nonmedical surgical care, and ambulatory costs. Articles also compare different cost methods, report on the annual costs incurred by veterans with common chronic diseases, and describe data issues that surround the cost of pharmaceuticals, such as drugs dispensed to ambulatory patients—one of the fastest growing areas of health care cost.

While focused on VA, the costing methods discussed in this supplement may be of interest to other systems. Canadian hospitals, the National Health System of Great Britain, and even some public health hospitals in the United States, for example, might use the methods described here.

VA's Health Services Research and Development Service is committed to high quality cost-effectiveness research and is proud of HERC's continuing contributions. In today's health care environment of rapid technological advances and significant financial considerations, VA and all health care

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decision makers need to weigh costs along with potential benefits. The methods described in this supplement provide important tools that will help us make informed decisions.

*John G. Demakis, MD*
Director, VA Health Services Research
and Development Service

# Preface

*Paul G. Barnett*
*Todd H. Wagner*
VA HSR&D Health Economics Resource Center,
VA Cooperative Studies Program,
and Stanford University

The Department of Veterans Affairs (VA) operates one of the largest integrated health care systems in the United States. It served 4.2 million veterans in 2001, operating a network of 172 hospitals and 859 clinics at a cost of $21.3 billion (U.S. Department of Veterans Affairs Veterans Health Administration 2002). As part of its mission, VA conducts clinical trials and health services research to improve the quality and effectiveness of patient care. Economics is an increasingly important part of these studies.

VA also has unique features that present both opportunities and challenges for economics research. Patients have a uniform set of health care benefits and few copayments, allowing patients equal access to health care. VA benefits include pharmacy, long-term care, mental health services, dental care, eyeglasses, hearing aids, prosthetics, home health care, and other services. VA also has comprehensive utilization databases, making it possible to track the quantity of care received by an individual throughout the system. The generous coverage and extensive databases provide a relatively complete understanding of the effect of interventions on all health services use. Such a comprehensive view is not possible in Medicare or private payer databases, in which benefits are generally more limited and separate organizations often provide behavioral health and long-term care.

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Despite the advantages of VA as a site for medical care research, health economics studies face a number of hurdles. VA is an integrated system with budget allocations based on the number of individuals served. Physicians are salaried employees, and care is almost always provided without billing patients or third party payers. Billing data are used to estimate costs in other parts of the U.S. health care system. In the absence of this source of information, VA researchers have developed other methods for estimating costs.

## VA INITIATIVES TO IMPROVE HEALTH ECONOMICS RESEARCH

In early 1997, the VA Health Services Research and Development Service (HSR&D) formed a committee to consider how to improve research on the cost of VA care. HSR&D leadership was concerned that many research proposals were not using appropriate methods of determining cost. A second concern was substantial duplication of effort, with independent researchers "reinventing the wheel" for different studies.

The committee was made up of VA health economists and other health services researchers. In September 1997, the committee issued a report that offered guidance to researchers wishing to study the cost of VA care. The committee concluded that the current methods needed improvement and organized a meeting to discuss cost issues.

The meeting was held in February 1998. It was attended by 45 economists, health services researchers, and policy makers, from both in and outside VA. Prior to the meeting, discussion papers were drafted. These provided attendees with information about VA economics research and provided a framework for discussion. The meeting attendees wrote a consensus statement, with recommendations to HSR&D. The meeting recommendations and discussion papers were subsequently published (Swindle et al. 1999).

Meeting attendees recommended that costs be determined with a blend of methods, combining direct primary measurement with costing based on administrative data. The attendees identified needed improvements to the VA infrastructure. Since most studies need cost estimates based on administrative data, it was recommended that this activity be conducted by a national center. It was also recommended that the center provide information, consultant services, and training.

HSR&D acted on these recommendations, publishing a request for proposals for an economics center in September 1998. Competing proposals were peer reviewed. In September 1999, funding was allocated to researchers at the HSR&D Center of Excellence located in Palo Alto, California.

The VA Health Economics Resource Center (HERC) was founded with the mission of improving the quality of VA health economics research. HERC's initial goals reflected the needs identified in the 1998 economics consensus statement. The primary focus was on the determination of VA health care costs. Specific goals included improved methods of direct measurement of health care cost, the creation of a comprehensive set of estimates of the cost of all VA health care encounters, and the documentation of a newly emerging VA cost allocation system, the Decision Support System (DSS). HERC set out to document VA financial databases, to describe methods of estimating hospital costs with regression analysis, and to support methods of determining non-VA costs and patient-incurred costs. Finally, HERC began offering training and consulting services.

## ARTICLES IN THIS SUPPLEMENT

This supplement describes the initial accomplishments of HERC. Five articles describe improved methods of cost determination; the sixth contrasts the methods and offers suggestions on how to choose among them. The remaining article provides patient-level information on the cost of health care provided to VA patients with different chronic diseases.

The first three articles in this supplement describe a major focus for HERC, the creation of a comprehensive VA cost database. In the absence of billing data, individual researchers had to undertake the daunting task of assigning a cost to each VA hospital stay and outpatient visit. Prior to HERC, independent economists working on different studies did this work. Duplication of effort was common and not a good use of scarce research resources. With the funding of the center, a more thorough job of cost determination could be done than by any single investigator working alone.

HERC combined VA cost and utilization databases with non-VA measures of relative value to estimate the cost of all inpatient and outpatient care provided by VA since 1 October 1997. These HERC cost estimates were constructed by assuming that each encounter had the average cost of all encounters with the same characteristics. We thus refer to these as "average cost" estimates and the comprehensive set of estimates as the HERC "average cost" database. These estimates are analogous to the "gross costs" described by the U.S. task force on cost effectiveness and health and medicine (Luce et al. 1996).

The scope of the average cost effort is quite large. VA provided nearly 700,000 hospital stays and 63.6 million outpatient visits in the fiscal year ending 30 September 2000 and spent some $19.3 billion on health care. This is 9 percent of the $224.4 billion spent by the U.S. Medicare program in 2000 (Levit et al. 2002).

The first article in this supplement, by Wagner, Chen, and Barnett (2003 [this issue]), describes estimation of the costs of acute VA hospital stays for medical and surgical care. The relationship between resource use and the characteristics of hospital stays was derived from data on non-VA hospital stays. We considered using hospital stay data from Medicare or from the Healthcare Cost and Utilization Project. The project's data have the advantage of including patients who were younger than 65, but they do not track the number of days spent in intensive care, which is included in Medicare data. We used the Medicare data because we found that the number of days in intensive care was more important than age in explaining the cost of hospital stays, controlling for other factors.

A regression model was estimated to determine how cost-adjusted charges incurred in non-VA hospitals were affected by characteristics of the stay, such as the diagnosis related group, the length of stay, the number of days in the intensive care unit, and patient demographics. The regression identified 74 percent of the variation of resource use, a great improvement over earlier efforts that used regressions with VA cost data (Barnett 1997). The parameters from this model were combined with the characteristics of VA hospital stays. The predicted costs were then adjusted to reflect actual expenditures for hospital care, as reported in the VA Cost Distribution Report, a cost allocation report that provides the cost of departments at each VA hospital.

The second article, by Yu, Wagner, et al. (2003 [this issue]), describes estimation of the cost of rehabilitation, mental health, and long-term hospital stays. It makes a unique contribution by using case mix measures to estimate the cost of nursing home stays.

The case mix measures were estimated using data from periodic assessments of every VA nursing home patient. These assessments evaluate patient acuity and assign each individual to a resource utilization group. Each resource utilization group has an associated value representing the relative quantity of staff resources required for care (Fries 1990). VA assesses nursing home patients at admission and every April and October thereafter. These longitudinal measures were combined to estimate the relative cost of long-term care. A regression model was used to estimate the acuity of patients who died or were discharged more than 90 days after their previous assessments.

The third article, by Phibbs et al. (2003 [this issue]), describes the method of determining the cost of ambulatory care. VA characterizes outpatient visits using current procedural terminology codes, the same system used by non-VA providers to prepare patient bills. HERC used the reimbursement schedules of Medicare and other health care payers to estimate hypothetical payments for ambulatory care encounters. These payments were adjusted to reflect the actual aggregate cost of VA ambulatory care departments.

Since VA is largely a hospital-based provider, a challenging aspect of this study was to estimate facility costs, which are distinct from the costs of physicians and other clinicians. Facility costs are significant. When care is provided in an ambulatory care facility, the U.S. Medicare program spends about as much on facility fees as it does on the services of physicians and other clinicians. Ambulatory care facilities have traditionally submitted itemized bills, but there was no published data on the average bill or the average Medicare reimbursement for specific services. This study took advantage of the new Medicare payment method for facilities: each procedure has been assigned to an ambulatory payment category, and a payment rate has been set based on historical payments to facilities.

The "average cost" estimates described in these three articles represent an important step forward for VA health economics researchers and are an example of techniques that may be used in other health care systems. If the analyst has detailed utilization data and department-level cost estimates, then the cost of individual patient care encounters can be estimated using relative values estimated from data of comparable providers. U.S. providers that lack billing data, such as those hospitals operated by managed care organizations, could base cost estimates on models estimated from data of U.S. hospitals with Medicare data. Canadian hospitals could also estimate their costs by constructing models from those Canadian hospitals that have adopted activity-based patient-level accounting systems.

Because of the assumptions required to prepare the "average cost" estimates, they are not appropriate for all studies. Each of the methods articles explains the specific limitations in more detail, but it is important to remember that cases with the same observed characteristics are assigned the same costs. Direct measurement is needed to find the cost of treatment innovations and the cost of care where there are no comparable non-VA providers.

The fourth article, by Smith and Barnett (2003 [this issue]), describes methods of determining costs by direct measurement. Although many studies have directly measured the cost of health care interventions, there is surprisingly little literature that gives guidance on how this should be done. This article seeks to close that gap. It describes how characteristics of the analysis, such as its perspective and time frame, affect the methods that are used.

The article also describes methods of assessing the time spent by staff, including time and motion studies, activity logs, and surveys of managers. The article notes that the hourly cost of employing staff must be adjusted for "nonapplied" time spent on administrative work, vacation, or sick leave; without this adjustment, the analyst will understate costs.

Smith and Barnett also describe methods of measuring patient-incurred cost. The article reviews methods of determining health care utilization from a

patient survey, a technique that is often needed to determine cost of care away from the study site. It discusses VA data sources for salaries, supplies, and capital. With the exception of this description of VA data, the article describes methods and considerations that apply equally to non-VA settings.

The fifth article, by Smith and Joseph (2003 [this issue]), describes VA data on the cost of pharmaceuticals. It describes four new databases of prescriptions filled by VA facilities nationwide. One database identifies drugs provided to inpatients. All of the databases have drug cost information. Prescription-level data make it much easier to gather information on the complete cost of health care, including drugs dispensed to ambulatory patients, which is one of the fastest growing areas of health care cost. There are few other national databases of prescription drug use; the U.S. Medicare program does not include a drug benefit. Such data also make it possible to conduct observational studies of pharmaceutical use, for example, comparisons of patients at facilities that include a drug on their formulary to patients at locations that do not.

The sixth article, by Barnett (2003 [this issue]), compares different cost methods. It describes VA cost and utilization data. It describes ways to determine cost by direct measurement, preparation of a pseudo-bill, and the estimation of a cost regression. It provides an overview of the HERC average cost data sets, created using a pseudo-bill and cost regression methods. It also describes the data from the VA activity-based cost allocation system, an implementation of the DSS. The article describes the strengths and drawbacks of each method. The choice of method represents a trade-off between accuracy and the resources available to conduct the study. This article offers the reader guidance on how to target research resources so that the most accurate methods are used where they are most needed.

The final article in the supplement combines the HERC average cost database with VA pharmacy cost data to report the annual health care costs incurred by veterans with common chronic diseases (Yu, Ravelo, et al. 2003 [this issue]). Few other studies have systematically looked at the costs associated with a large number of diverse chronic diseases. Patients with chronic diseases appear to account for a greater share of the VA costs than they do in other systems. Those patients who had at least 1 of the 29 chronic diseases studied accounted for 72 percent of VA patients and 96 percent of VA costs. This article is unique because it describes patients in a large national system, examines the relationship between chronic disease and the cost of pharmaceuticals dispensed to ambulatory patients, and includes the cost of specialized treatment of substance use disorders and other mental health conditions.

## ACCOMPLISHMENTS AND FUTURE DIRECTIONS FOR THE VA HERC

The mission of HERC is to increase VA's capacity to conduct high-quality health economics research and cost-effectiveness studies so that the nation and the nation's veterans may get the best possible health care value from available resources. The VA HSR&D service recently approved a 5-year strategic plan for HERC.

To improve the usefulness of existing VA data, HERC will document VA data on pharmacy, prosthetics, capital, contract care, and the new VA general ledger. It will also document a new national department-level cost database from DSS and update its existing guide on the DSS encounter-level extracts.

HERC will continue to estimate the cost of all VA health care encounters but revise its methods to accommodate new procedure codes and diagnostic related groups. HERC is adding fields to its inpatient databases with the subtotal cost for each type of care and developing a national person-level cost data set.

HERC plans to develop and to improve methods of determining patient-incurred costs and the cost of veterans' non-VA care. The center will develop tools that researchers can use to access DSS data on the quantity and cost of intermediate health care products and create economic data sets needed by VA researchers, including tabulations of VA cost and utilization data, geographic wage data, and data on facility consolidations.

There is ongoing work to improve the quality of VA health care data. VA has created new databases, improved its coding practices, and adopted standardized procedures for DSS. Evaluation of the quality of data is an area of focus for HERC. HERC plans to evaluate the quality of pharmacy, prosthetics, and ambulatory care data, as well as the DSS national cost extracts. HERC will also compare cost methods, comparing DSS cost data to the HERC average cost data.

HERC continues to offer training, a consulting service, and Web-based information to VA researchers. It will conduct a formal analysis of the needs of VA health economics researchers and will report the findings to the HSR&D.

HERC economists are also engaged in clinical trials and health services studies that evaluate the cost effectiveness of a variety of clinical problems, from the diagnosis of lung cancer to the treatment of heart disease, AIDS, and substance use disorders. This work is providing practical experience so that they may work with other VA economists to improve the quality of health economics research.

Biomedical discoveries and technological advancements are providing clinicians with an increasing set of options. They are also causing the cost of

health care to continue to increase. Because resources are limited, every innovation cannot be adopted. In the past, health care decision makers have used effectiveness criteria to evaluate new treatments. They are increasingly interested in economics. New medical care interventions are no longer judged solely on their ability to improve outcomes; decision makers want to understand whether they yield sufficient value to justify their cost. Health economics will play a key role in deciding what medical care will be offered and to whom.

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# Using Average Cost Methods to Estimate Encounter-Level Costs for Medical-Surgical Stays in the VA

*Todd H. Wagner*
VA HSR&D Health Economics Resource Center and Stanford University
*Shuo Chen*
VA HSR&D Health Economics Resource Center
*Paul G. Barnett*
VA HSR&D Health Economics Resource Center and Stanford University

*The U.S. Department of Veterans Affairs (VA) maintains discharge abstracts, but these do not include cost information. This article describes the methods the authors used to estimate the costs of VA medical-surgical hospitalizations in fiscal years 1998 to 2000. They estimated a cost regression with 1996 Medicare data restricted to veterans receiving VA care in an earlier year. The regression accounted for approximately 74 percent of the variance in cost-adjusted charges, and it proved to be robust to outliers and the year of input data. The beta coefficients from the cost regression were used to impute costs of VA medical-surgical hospital discharges. The estimated aggregate costs were reconciled with VA budget allocations. In addition to the direct medical costs, their cost estimates include indirect costs and physician services; both of these were allocated in proportion to direct costs. They discuss the method's limitations and application in other health care systems.*

***Keywords:*** *short-stay hospitalization; cost; charges; expenditures*

The U.S. Department of Veterans Affairs (VA) maintains centralized databases containing detailed hospital discharge abstracts, but encounter-level charge or cost information has not been readily available for cost and outcome

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analyses. This lack of data reflects the fact that VA interacts with third party payers for only a tiny percentage of the care it provides, and therefore it does not routinely generate patient bills.

As described by Barnett and Wagner (2003 [this issue]), one objective of the VA Health Economics Resource Center (HERC) has been to create patient-level cost estimates. Before HERC, researchers estimated VA costs as needed. Since no standard research methodology was in place, many of the cost estimates were not comparable (Chapko, Ehreth, and Hedrick 1991). Some progress was made by linking department-level cost and utilization data to estimate average daily rates for inpatient care (Barnett, Chen, and Wagner 2000). However, using average daily rates for medical or surgical discharges makes extreme assumptions that are generally not valid. For example, this approach assumes that appendectomies and heart transplants with the same length of stay (LOS) had equal costs. Recently, Barnett (1997) used a regression to estimate an individual's cost as a function of the deviation from a medical center's average. One problem with this approach was that the lack of institutional-level variation made it difficult to estimate precisely individual-level costs.

This article describes HERC's method for estimating the cost of VA health care encounters in fiscal year (FY) 1998 to FY 2000. Our goal was to develop a database of long-run national average costs. Intended for cost-effectiveness analysis, these data do not account for hospital market factors, nor were they designed to capture short-run fixed costs. These caveats and limitations are described in the methods and the discussion sections, but they are critical for using the data appropriately.

## NEW CONTRIBUTION

Cost data are missing from VA utilization databases. In the past, researchers wanting to conduct cost-effectiveness analysis first had to estimate encounter-level costs. We use regression models to estimate the cost of inpatient medical-surgical discharges for FY 1998 to FY 2000. This method assumes that every encounter has the average cost of all encounters that share the same discharge characteristics. The cost regression exploits variation in major diagnostic category (MDC), diagnosis related group (DRG), LOS, number of diagnoses, inpatient death, sex, age, and number of intensive care unit (ICU) days. It captures

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resource variation that would be missed by using Medicare reimbursement rates based on the stay's DRG to calculate costs. The functional form allows for nonlinearities and interactions, and the final model accounts for approximately three-quarters of the variance in cost-adjusted charges. These cost estimates are in a VA database that can be merged to VA utilization records.

## METHOD

### OBJECTIVE AND DEFINITION OF COST

Our goal was to create an encounter-level cost database for VA medical and surgical inpatient care. More specifically, we estimated long-run national average costs, and in doing so, we treated all short-run fixed costs (e.g., capital) as long-run variable costs. We distributed VA fixed costs in proportion to VA variable costs, based on costs reported in the VA Cost Distribution Report (CDR). In addition, we did not take market-level forces or market-level input prices into account. Although market-level forces, defined as either variation in wages or availability of technology (Baker 1997; Baker and Corts 1996), can affect the supply curve, we were interested in estimating VA average costs for the nation.

Our methodological approach involved developing a cost regression for medical and surgical inpatient stays with Medicare data and using the regression coefficients to impute costs for VA inpatient encounters. Through the regression model, we estimated the relationship between cost-adjusted charges, the dependent variable, and diagnostic and demographic information, the independent variables. The beta coefficients from the regression model were then used to impute "costs" in the VA data set. All stays with the same diagnostic and demographic information were assigned an average cost, also known as a gross cost (Gold et al. 1996). Therefore, the fidelity of the cost regression was determined, in part, by the model's specifications and the independent variables.

We reconciled the costs from the regression model with the VA budget allocation. The VA has a national budget, and each local medical center has a budget. We reconciled to both, generating separate national and local estimates. We strongly encourage researchers to use the national estimates. By construction, the averages of the national and the local estimates are the same, but the local estimates have more variation and larger tails as evidenced by the ratio of local to national estimates, which ranged from 0.62 to 11.64 in FY 1999. Researchers may choose to use the local estimates to see if results hold. However, as mentioned above, the local estimates do not account for market-level

effects. Therefore, differences in local estimates may reflect budget allocations, rather than input prices or the relative efficiency of production.

## COST REGRESSION

We developed our cost regression using a subset of the 1996 Medicare Provider Analysis Review (MEDPAR) file (Centers for Medicare and Medicaid Services [CMS] 2003). Although we could have used a random sample of the 1996 MEDPAR file, we chose to use a subset of veterans with the assumption that this placed a greater weight on clinical and demographic factors that are VA relevant. A group of VA researchers has identified a cohort of Medicare enrollees who are also enrolled in VA (Wright, Hossain, and Petersen 2000; Wright, Lamkin, and Petersen 2000). The cohort contains all veterans who were users of either inpatient or outpatient VA services between 1992 and 1994 and who had their 65th birthday in 1994. The file had 372,046 hospital stays. From this cohort, we focused on hospitalizations in the continental United States. We also excluded claims for MDC 15 (i.e., newborns and other neonates with conditions originating in the perinatal period), as VA did not cover these services before 2001.

The MEDPAR data set includes a variable for total charges. Given that total charges are often greater than costs, we used the Medicare Cost Report to calculate each hospital's total cost to total charge ratio. The MEDPAR includes a hospital identifier that can be merged with the Medicare Cost Report. After linking the hospital-level cost to charge ratio to the MEDPAR data set, we were able to adjust patient-level total charges with a hospital-specific ratio of cost to charges. In our merged data set, the average of the cost-to-charge ratio was 0.60. Therefore, this adjustment tends to deflate the costs. In addition, it removes hospital-specific cost or accounting idiosyncrasies. In the cost regression, we used cost-adjusted charges as the dependent variable. We estimated the regression using ordinary least squares (OLS). Alternative models with logged costs are described in the sensitivity analysis.

We restricted our choice of independent variables to those available in both the MEDPAR and VA databases. Past literature guided our selection of independent variables (Barnett 1997). To account for resource use, we used the DRG, merged to the 1996 DRG weight file from the CMS. DRG weights are resource-based relative value weights publicly available on CMS's Web site. We captured additional variation in resource use by adding LOS as a positive integer. We also included the difference between the actual LOS and the expected LOS for a given DRG. In effect, this acts as an interaction between DRG and LOS. To allow for nonlinearities, positive and negative deviations in the actual and expected LOS were allowed to vary independently and in a

nonlinear fashion (i.e., squared and cubic terms were included). In addition, we interacted the medicine MDC and surgery MDC with LOS.

## VA DATA

After estimating the cost regression with MEDPAR data, we used the beta coefficients to impute VA costs. To impute meaningful estimates, we reorganized the VA data to have an equivalent structure to the MEDPAR data. A VA discharge record can include long-term care, rehabilitation, specialty substance abuse and psychiatric treatment, intermediate medicine, and domiciliary care. Many of these non-medical-surgical stays would be treated as separate stays and excluded altogether from the MEDPAR database, which includes inpatient care from short-stay hospitals. This article covers only the cost of medical-surgical care. The method for estimating the costs of rehabilitation, mental health, and long-term care is handled elsewhere in this issue (Yu et al. 2003 [this issue]).

To make a VA medical-surgical discharge data set analogous to the MEDPAR database, we worked with the VA bedsection file. A bedsection is similar to a non-VA hospital ward or department. We adopted the rule that transfers between medical-surgical bedsections were part of the same stay. If a person was transferred from a medical-surgical bedsection to a non-medical-surgical bedsection, we ruled that the medical-surgical stay ended. For example, a transfer from a medical-surgical bedsection to a non-medical-surgical bedsection and back to a medical-surgical bedsection would yield one non-medical-surgical and two medical-surgical discharge records. While combining transfers within contiguous medical-surgical bedsections (i.e., bedsection stays in which the discharge and admission dates were the same), we tracked both overall LOS and days in the ICU. Each bedsection record has an associated DRG. We merged the DRG to the CMS DRG weight public use file, and the DRG with the highest weight was retained under the assumption that this DRG more closely reflected costs and would be used to maximize payment in the non-VA sector.

## POSTESTIMATION FIXES

After estimating VA costs with the cost regression, 3,032 (0.7 percent) of the 455,926 medical-surgical hospitalizations had negative costs. This result was an artifact of using a linear regression model. Rare combinations of right-hand-side variables lead to negative predictions. Although negative costs present a clear estimation problem, other cases had implausibly low costs. Forty-two hospital stays had positive costs less than $5. We decided to set a

floor for the estimated discharge cost. The floor was established by using the regression model (see Table 1) to simulate the cost of staying an additional day. All other factors being equal, if a person stayed an additional day, MEDPAR cost-adjusted charges increased by an average of $684.75. A total of 9,609 (2 percent) VA stays had costs less than $684.75, and 86 percent of these cases had a 1-day LOS. These cases were all given $684.75.

## RELIABILITY AND VALIDITY OF THE COST REGRESSION

We tested the model's validity and robustness using three procedures. First, we identified outliers and reestimated the model after removing approximately 1 percent, 2 percent, and 7 percent of the most influential outliers. We empirically identified outliers using Cook's distance after estimating the cost regression with the Medicare data. Conceptually, Cook's distance is an *F* test comparing the beta coefficients from the full data set to the beta coefficients from the data set excluding the one case (Cook and Weisberg 1982).

We then tested the model's fit by separating Medicare data into quartiles. Within each quartile, Medicare cost-adjusted charges and estimated costs were compared using Pearson's correlation coefficient. Finally, we also tested the model's fit using different 50 percent random samples of the Medicare data. The cost regression was estimated with one of the random samples, and then predicted costs were estimated for the other half of the sample, allowing an out-of-sample comparison of estimated costs and cost-adjusted charges.

We tested whether the model was highly dependent on these data and whether the estimated costs changed significantly if Medicare data from another year were used. Using 1994 and 1995 MEDPAR data for veterans who received VA care, we estimated the same regression model. The beta coefficients from these three models were compared. The 1994, 1995, and 1996 cost regressions were also used to predict 1996 Medicare costs. This allowed us to test the reliability of the cost regression, using actual 1996 cost-adjusted charges as the criterion.

We compared estimated VA costs in the different MDCs, stratified by whether the DRG was surgical or medical. The costs were then ranked from least expensive MDC to most expensive. This ranking was done for MEDPAR, as well as the Healthcare Cost and Utilization Project (HCUP) data. The HCUP data set is a nationally representative discharge data set, based on people of all ages. The HCUP data were used to verify that the method and cost estimate could be used in other circumstances. Rather than comparing the relative VA, Medicare, and HCUP costs, we compared the relative rankings of each MDC across the data sets. We did not want to directly compare costs given that they represent different years and that Medicare and HCUP include different cost

TABLE 1 Ordinary Least Squares Regression Model Estimating Discharge Cost-Adjusted Charges

| *Characteristic* | *Beta Coefficient* | t *Statistic* |
|---|---|---|
| Died in hospital | 2,671.211** | 46.69 |
| Sex (female = 1, male = 0) | 32.909 | 0.54 |
| Age in years | –34.223** | 18.48 |
| Number of diagnoses | 619.044** | 7.63 |
| Number of diagnoses squared | –146.702** | 8.83 |
| Number of diagnoses cubed | 10.975** | 10.73 |
| Length of stay (LOS) in days | 104.255** | 11.48 |
| Positive deviation from DRG-specific average LOS (POSLOS) | 670.950** | 66.39 |
| Negative deviation from DRG-specific average LOS (NEGLOS) | 182.499** | 6.15 |
| NEGLOS squared | –109.890** | 13.77 |
| POSLOS squared | –0.717** | 32.99 |
| NEGLOS cubed | –4.588** | 8.36 |
| POSLOS cubed | 0.000006 | 0.17 |
| 1996 DRG weight | 4,860.036** | 76.30 |
| DRG weight squared | –255.164** | 23.11 |
| DRG weight cubed | 12.973** | 25.65 |
| Surgical MDC | 1,069.883** | 13.68 |
| Surgical MDC* LOS | –42.315** | 3.79 |
| Surgical MDC* POSLOS | 421.532** | 26.99 |
| Surgical MDC* NEGLOS | 328.304** | 9.06 |
| Surgical MDC* POSLOS squared | –1.384** | 7.72 |
| Surgical MDC* POSLOS cubed | 0.001 | 1.74 |
| Surgical MDC* NEGLOS squared | 47.498** | 5.64 |
| Surgical MDC* NEGLOS cubed | 3.637** | 6.59 |
| Days in ICU | 593.037** | 82.76 |
| ICU days squared | 10.274** | 37.86 |
| ICU days cubed | –0.033** | 18.24 |
| Constant | 413.766* | 2.28 |
| Observations = 321,583 | | |
| $R^2$ = .74 | | |

Note: DRG = diagnosis related group; MDC = major diagnostic category; ICU = intensive care unit.
*Significant at .05. **Significant at .01.

components compared to the VA. For example, Medicare and HCUP exclude physician services, whereas they include capital financing and malpractice.

Comparing the rankings provided a measure of agreement. To assess the statistical significance of the agreement, Kappa statistics were calculated.

## OBSERVATION DAYS

Beginning in 1997, VA created seven new codes to report inpatient care provided in observation units. An observation bed stay is less intensive than a medical-surgical stay, and it does not have an associated DRG. This prevented us from including these data in the cost regression. We decided to assign each observation day at the marginal cost of an additional day in a nonobservation bedsection ($684.75). This estimate was calculated by using the regression model presented in Table 1 to estimate the additional amount that would have been incurred if the patient stayed one more day.

## RECONCILING ESTIMATED AND ACTUAL VA COSTS

The VA tracks department-level expenditures in the CDR. VA expenditures are recorded in the Financial Management System (FMS). The CDR is created by distributing costs reported in the FMS to cost distribution accounts of the CDR. The distribution of costs is based on estimates prepared by the service chiefs in each medical center. At the end of each FY, a cumulative CDR is prepared, and it is reconciled to the costs reported in FMS. We adjusted our estimates so that the sum of both the national and local estimates was equal to the VA medical-surgical budget allocation reported in the CDR.

The CDR includes most VA health care costs, including the cost of physicians. We distributed physician costs across inpatient stays in proportion to facility costs. The CDR tracks capital depreciation, but it lacks information on the cost of capital financing. The CDR also lacks information on malpractice expenses. Both of these costs are covered by other federal agencies. Therefore, our cost estimates lack these two components.

When tallying the CDR costs, we excluded costs for contract care, home care programs, and benefits included in the medical or surgical cost distribution accounts because the corresponding services are often not captured in the utilization databases. We also excluded the cost of 16 facilities that do not provide patient care. These 16 sites provide central administration, which may involve activities that are more characteristic of a health care payer, rather than a health care provider. We included indirect costs by assigning them to each department in proportion to the department's share of direct costs.

Two hurdles arose when we merged the VA utilization data to the CDR cost data. First, we had to account for VA medical center mergers. If VA medical centers merged during an FY, we merged their utilization and cost data for the

entire FY. It was not possible to separate accurately costs and utilization before and after the merger.

The second hurdle was that the utilization data reported all discharges ending in the FY. The data set includes stays that began in prior FYs but not those stays that end in subsequent years. In contrast, the CDR reports costs for an FY, including costs for patients not yet discharged. Ignoring this difference would be equivalent to assuming that bed occupancy is constant over time. There is a trend in VA to shorten LOS and to reduce hospitalizations. Consequently, the estimated cost of discharges that began in earlier years would be too large in current-year dollars given that current-year dollars are being spread over fewer patients each year. To adjust the dollars to more closely reflect the discharge view of the utilization data, we calculated the percentage of beds full at the end of the FY compared to the beginning of the year (0.93 for FY 1998, 0.98 for FY 1999, and 0.93 for FY 2000). We used this ratio to deflate the estimated costs for stays that started in prior FYs.

After accounting for mergers and adjusting the estimated costs to the FY, we reconciled the estimates to VA budget allocations. The reconciliation with the VA medical center produced a local cost estimate, whereas reconciling to the entire VA produced a national cost estimate. By construction, the averages of the national and the local estimates are the same, but the national and local estimates differ for any one encounter. The latter may reflect differences in input prices, but it may also reflect different accounting practices.

## RESULTS

### COST REGRESSION

The cost regression is presented in Table 1. The regression model is parsimonious in that it only used eight discharge descriptors, yet the model allows for interactions and nonlinearities between important variables including LOS and DRG weight. The final model accounted for almost three-quarters of the variance among veterans who used Medicare, and it was highly significant ($F_{27,321,555} = 33396.7$, $p < .0001$).

### RELIABILITY AND VALIDITY OF ESTIMATED VA COSTS

We estimated the cost regression with Medicare data, saving Cook's distance. We then ran alternative models, removing an increasing percentage of outliers from the sample. The results indicated that the model's overall $R^2$ did not increase substantially when eliminating outliers. In fact, when we eliminated the top 1 percent of outliers, the model's $R^2$ decreased.

We also separated the sample into quartiles according to cost-adjusted charges. Again, eliminating the outliers did not universally improve the model's fit among the quartiles. Table 2 shows Pearson's correlation coefficients between the estimated costs and the Medicare cost-adjusted charges. Given these results, we concluded that omitting outliers would be based on an arbitrary limit, which could lead to a worse fit. Alternatively, one could identify outliers according to Medicare's outlier designator, but eliminating these cases had little effect.

An unexpected finding was that the regression model fit the large costs (quartile 4) considerably better than the low costs. Efforts to improve the model's fit with the low-cost observations often exacerbated the fit in the high-cost cases and increased the model's absolute error, measured as the difference between cost-adjusted charges and estimated costs. A semilog model, which is often used for skewed cost data, produced estimates that were weakly correlated (.106, see Table 2) with cost-adjusted charges.

The split-sample analysis confirmed the robustness of the model. As Table 2 shows, when we estimated the cost regression with a randomly selected half of the data and predicted the costs in the other half, the correlation between cost-adjusted charges and estimated costs remained consistent across quartiles.

The estimated costs were robust to the input data. Simulated VA costs using 1994, 1995, and 1996 MEDPAR data were correlated above .99. To compare estimated costs to cost-adjusted charges, we used the cost regression with 1994, 1995, and 1996 MEDPAR data restricted to veterans who had used VA services to estimate costs for the 1996 MEDPAR data. We were then able to compare estimated costs to the 1996 Medicare cost-adjusted charges, using the latter as the reference. Again the models were adept at estimating costs. Table 3 shows the correlations between the 1996 cost-adjusted charges and the estimated costs.

After estimating VA costs, we divided the sample into surgical and medical DRGs. We ranked the MDCs according to the average VA cost. We then ranked Medicare and HCUP costs in the same way. Agreement of ranks, as estimated using Kappa statistics, within the surgical and medical DRGs was statistically significant with *p*-values at or below .001. The agreement was slightly higher for the surgical DRGs than for the medical DRGs. Tables 4 and 5 show the rankings and the average costs for each medical and surgical MDC, respectively.

## SENSITIVITY ANALYSIS

In the cost regression, we used the 1996 MEDPAR file restricted to veterans who received VA care. Other data sets, such as HCUP, could be used to estimate the cost regression. Both the MEDPAR and HCUP data sets report

TABLE 2 Correlation Coefficients of MEDPAR Cost-Adjusted Charges (CAC) and Estimated Costs by Quartile

| | *Quartile 1: CAC < $2,605* | | *Quartile 2: $2,605 < CAC < $4,484* | | *Quartile 3: $4,484 < CAC < $8,472* | | *Quartile 4: CAC > $8,472* | |
|---|---|---|---|---|---|---|---|---|
| | *In Sample* | *Out of Sample* | *In Sample* | *Out of Sample* | *In Sample* | *Out of Sample* | *In Sample* | *Out of Sample* |
| Correlation coefficients | | | | | | | | |
| Full models | | | | | | | | |
| ESTCOST | .126 | .190 | .301 | .291 | .389 | .357 | .814 | .809 |
| LGCOST | .083 | .109 | .303 | .290 | .390 | .381 | .389 | .106 |
| Outlier omitted models | | | | | | | | |
| 1. | .057 | .204 | .309 | .005 | .396 | .250 | .641 | .699 |
| 2. | .071 | .209 | .313 | .011 | .398 | .279 | .718 | .750 |
| 3. | .185 | .202 | .313 | .305 | .393 | .392 | .769 | .775 |
| Sample size | 38,304 | 38,144 | 39,167 | 38,594 | 39,939 | 40,801 | 43,348 | 43,286 |

Note: MEDPAR = Medicare Provider Analysis Review; ESTCOST = estimated cost from the linear cost regression; LGCOST = estimated cost from the logged cost regression. In model 1, the cost regression excluded cases with Cook's distance greater than .001 (least restrictive). In model 2, the cost regression excluded cases with Cook's distance greater than .0001 (more restrictive). In model 3, the cost regression excluded cases with Cook's distance greater than .00001 (most restrictive).

TABLE 3 Correlations in Estimated Costs Compared to 1996 Cost-Adjusted Charges

| | *Model 1* | *Model 2* | *Model 3* |
|---|---|---|---|
| MEDPAR cost-adjusted charges (1996) | .856 | .855 | .859 |
| Model 1 | 1.000 | | |
| Model 2 | .993 | 1.000 | |
| Model 3 | .997 | .996 | 1.000 |

Note: MEDPAR = Medicare Provider Analysis Review. Model 1 is the 1994 MEDPAR model estimating costs for 1996 data. Model 2 is the 1995 MEDPAR model estimating costs for 1996 data. Model 3 is the 1996 MEDPAR model estimating costs for 1996 data.

medical-surgical inpatient discharges, but MEDPAR is limited to Medicare enrollees older than the age of 65 and those younger than the age of 65 with a disability, while HCUP includes people of all ages. MEDPAR reports the number of days spent in the ICU, which is not captured by HCUP.

In deciding whether the cost regression should be estimated with MEDPAR or HCUP data, we ran a number of regressions with the MEDPAR and HCUP data and looked at model fit and absolute mean error. Including ICU days increased the $R^2$ from approximately .69 to .74. In comparison to ICU days, age is a relatively poor predictor of hospital costs and adds very little to the model's fit ($R^2$ increased .002). The absolute mean error between Medicare cost-adjusted charges and imputed costs was $2,662 and $2,825 for the models including and excluding ICU days, respectively. When age was excluded from the MEDPAR cost regression, the absolute mean error increased by $0.21. The age effect was statistically significant, but the results suggest that after controlling for other variables, it is more important to be able to adjust for ICU days than to include a wider distribution of ages. Consequently, we chose to estimate the cost regression using the MEDPAR data.

The cost regression's dependent variable was cost-adjusted charges. The unadjusted cost-adjusted charges were highly right skewed, raising questions about the appropriateness of using OLS regression. We used the log transform with the smearing estimator (Duan 1983) to test whether this produced a model with a better fit and whether this reduced error in the residuals. Although the log transform helped reduce the appearance of skewness, the nonlogged cost regression consistently performed better than models with logged cost-adjusted charges. OLS models had a higher $R^2$ than the semilog model. In addition, when we used a randomly selected half of the MEDPAR sample to predict with OLS and semilog models the cost of the other half, the OLS models consistently had substantially lower absolute mean error (i.e.,

TABLE 4 Ranks of Medical Major Diagnostic Categories from Least to Most Expensive

| | *VA (1998)* | | | *MEDPAR (1996)* | | | *HCUP (1996)* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Major Diagnostic Category* | n | *Average Cost* | *Average DRG Weight* | n | *Average Cost* | *Average DRG Weight* | n | *Average Cost* | *Average DRG Weight* | *VA Rank* | *MEDPAR Rank* | *HCUP Rank* |
| 14. Pregnancy and childbirth | 13 | 2,874 | 0.609 | 3 | 961 | 0.383 | 6,619 | 2,084 | 0.437 | 1 | 1 | 1 |
| 23. Factors influencing health status | 7,080 | 3,391 | 0.695 | 7,226 | 9,620 | 1.255 | 915 | 7,710 | 1.172 | 2 | 20 | 20 |
| 13. Female reproductive system | 190 | 3,565 | 0.742 | 19 | 4,379 | 1.002 | 154 | 3,371 | 0.865 | 3 | 7 | 3 |
| 2. Diseases of the eye | 1,127 | 3,584 | 0.634 | 162 | 3,910 | 0.669 | 57 | 3,581 | 0.654 | 4 | 3 | 5 |
| 9. Skin, subcutaneous tissue, and breast | 11,862 | 4,282 | 0.743 | 3,663 | 4,604 | 0.793 | 811 | 3,920 | 0.732 | 5 | 9 | 7 |
| 21. Injuries, poisonings | 4,994 | 4,294 | 0.714 | 1,891 | 4,238 | 0.804 | 601 | 3,497 | 0.703 | 6 | 6 | 4 |
| 3. Ear, nose, mouth, and throat | 5,082 | 4,620 | 0.816 | 1,567 | 3,539 | 0.677 | 310 | 3,060 | 0.663 | 7 | 2 | 2 |
| 16. Blood and Immunological disorders | 5,444 | 4,730 | 0.934 | 2,082 | 5,681 | 0.988 | 453 | 5,682 | 0.944 | 8 | 13 | 15 |
| 10. Endocrine, nutritional, and metabolic | 15,499 | 4,749 | 0.776 | 7,651 | 4,095 | 0.816 | 1,301 | 4,150 | 0.789 | 9 | 4 | 8 |
| 19. Mental diseases and disorders | 4,465 | 4,841 | 0.767 | 10,119 | 7,413 | 0.784 | 2,283 | 4,943 | 0.758 | 10 | 18 | 13 |
| 8. Musculoskeletal system | 11,139 | 4,945 | 0.767 | 6,768 | 5,504 | 0.775 | 1,395 | 4,592 | 0.757 | 11 | 12 | 11 |
| 12. Male reproductive system | 2,778 | 5,015 | 0.773 | 902 | 4,175 | 0.782 | 57 | 3,640 | 0.735 | 12 | 5 | 6 |

*(continued)*

TABLE 4 (continued)

| Major Diagnostic Category | VA (1998) n | VA (1998) Average Cost | VA (1998) Average DRG Weight | MEDPAR (1996) n | MEDPAR (1996) Average Cost | MEDPAR (1996) Average DRG Weight | HCUP (1996) n | HCUP (1996) Average Cost | HCUP (1996) Average DRG Weight | VA Rank | MEDPAR Rank | HCUP Rank |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6. Digestive system | 32,464 | 5,028 | 0.845 | 19,477 | 4,454 | 0.898 | 3,295 | 4,163 | 0.850 | 13 | 8 | 9 |
| 5. Circulatory system | 100,794 | 5,325 | 0.866 | 72,322 | 4,836 | 0.978 | 8,341 | 4,638 | 0.935 | 14 | 10 | 12 |
| 11. Kidney and urinary tract | 19,269 | 5,925 | 0.918 | 8,620 | 5,016 | 0.978 | 1,408 | 4,578 | 0.897 | 15 | 11 | 10 |
| 17. Myeloproliferative diseases | 9,452 | 6,400 | 1.137 | 3,288 | 7,433 | 1.403 | 672 | 7,275 | 1.247 | 16 | 19 | 19 |
| 1. Nervous system | 27,709 | 6,491 | 0.970 | 21,877 | 6,187 | 1.048 | 3,026 | 5,620 | 1.035 | 17 | 15 | 14 |
| 7. Hepatobiliary and pancreas | 14,109 | 7,075 | 1.191 | 4,782 | 5,786 | 1.194 | 953 | 6,404 | 1.162 | 18 | 14 | 17 |
| 4. Respiratory system | 60,941 | 7,930 | 1.236 | 51,919 | 6,771 | 1.329 | 5,377 | 6,193 | 1.250 | 19 | 16 | 16 |
| 18. Infectious and parasitic diseases | 6,003 | 9,052 | 1.238 | 6,995 | 6,830 | 1.381 | 1,004 | 6,685 | 1.327 | 20 | 17 | 18 |
| 25. HIV | 2,468 | 9,313 | 1.482 | 90 | 10,751 | 1.534 | 346 | 9,690 | 1.600 | 21 | 21 | 21 |
| 24. Multiple significant trauma | 58 | 15,416 | 1.954 | 148 | 15,326 | 1.954 | 47 | 11,460 | 1.954 | 22 | 22 | 22 |

Note: VA = U.S. Department of Veterans Affairs; MEDPAR = Medicare Provider Analysis Review; HCUP = Healthcare Cost and Utilization Project; DRG = diagnosis related group. Dollars are nominal and not adjusted for inflation. Comparison of VA rank to Medicare rank = 18.18 percent agreement, Kappa = .1429, $p = .0011$. Comparison of VA rank to HCUP rank = 22.73 percent agreement, Kappa = .1905, $p < .0001$.

cost-adjusted charges minus estimated charges) than the semilog models. Lipscomb et al. (1998) suggested that the ability to predict costs should be the primary concern when choosing the specification of the statistical model.

Transforming the dependent variable presents additional hurdles because the estimated costs need to be transformed back to the original metric (dollars). Although one can use retransformations, such as the smearing estimator (Duan 1983), this often requires arbitrary assumptions about the error distributions, and the point and variance estimates can still be biased (Mullahy 1998; Ai and Norton 2000; Manning 1998; Manning and Mullahy 2001). Some researchers have used cost regressions with heteroscedastic smearing estimates (Andersen, Andersen, and Kragh-Sorensen 2000). Given these limitations and our empirical evidence, we used OLS without transformation.

Variation in cost-adjusted charges is associated with variations in LOS and the DRG. We faced several options for including these variables in the cost regression. We could have included LOS without making any transformations, such that LOS would be a positive integer. Variations on this approach (e.g., using dummy variables) were also considered, but in every case, these approaches yielded a lower $R^2$ and a higher absolute mean error than the current model.

Although we used DRG weights to account for the approximately 500 DRGs, we could have used dummy variables. The gain in $R^2$ from using DRG-specific intercepts was approximately 1 percent greater than the models in which we included DRG weight. Given the complexity and instability of estimating a model with more than 500 collinear covariates, we chose to use DRG weights instead of DRG-specific intercepts.

## DISCUSSION

The cost regression we estimated with 1996 MEDPAR data accounted for almost three-quarters of the variance in cost-adjusted charges. The cost regression did a better job of predicting high-cost stays than low-cost stays, and it proved to be highly robust to outliers. It was also robust to the year of input data: when the cost regression was run with 1994, 1995, and 1996 MEDPAR data, the estimated costs were correlated above .99 with the cost-adjusted charges. These findings suggest that the cost regression produced reliable cost estimates.

To assess the validity of the cost regression, we ranked the medical and surgical MDCs. Tables 4 and 5 show that the rankings are relatively consistent, and the agreement between VA, HCUP, and Medicare data is statistically significant. There was slightly more concordance in the surgical categories of care compared to the medical categories. This might be because the cost regression

did a better job estimating high-cost cases than low-cost cases. These checks provide limited evidence that the average cost data for medical-surgical stays are valid and reliable.

A virtue of this method is that long-run average costs can be estimated with only eight variables from discharge records: MDC, DRG, LOS, number of diagnoses, death in hospital, sex, age, and number of ICU days. When we estimated costs with MEDPAR data, we accounted for 74 percent of the variance. Unfortunately, some data sets, such as HCUP, lack ICU days. This model could be used without ICU days, but the model's $R^2$ decreased from .74 to .69. Future research is needed to explore these cost estimates in more detail. In particular, comparing these costs to the VA Decision Support System will provide additional feedback on the validity and reliability of these cost estimates.

## LIMITATIONS

One limitation of using MEDPAR data to estimate VA costs is that only hospital charges are reported. Physician charges are not included. Instead, they are reported on the Medicare physician/supplier part B files. Including the cost of physician services is important in determining VA costs. Physician costs are reported in the CDR; therefore, reconciling the estimated MEDPAR costs to the CDR distributes physician costs to each record in direct proportion to the hospital costs. Future research will look at alternative ways to estimate VA physician costs for inpatient stays. One option involves using resource-based weights calculated by Welch and Larson (1989) as an alternative to obtaining the physician services part B file and laboriously calculating these weights. Nevertheless, at this time, the VA costs include physician services, and these costs are allocated proportionately in accordance with the hospital costs.

Another limitation is that the cost regression did not capture all of the variance. A consequence of this is that the estimated costs have less variance and fewer outliers than the true VA costs. This limitation has two important implications. First, it suggests that researchers may not want to use the estimated costs for identifying high- or low-cost outliers. Second, it implies that the cost regression biases the variance of the estimated costs downwards. The reason for this is that many factors that affect costs are not included in the cost regression. Stays that may differ in cost but have identical observed factors are assigned the same estimated cost. In Table 6, we show the costs reported by 1996 MEDPAR for five DRGs, along with the estimated costs from our regression. As is clear from this table, the standard deviations for estimated costs are smaller than the actual costs. Also, note that the minimum and maximum values are attenuated toward the mean.

TABLE 5 Ranks of Surgical Major Diagnostic Categories from Least to Most Expensive

| | *VA (1998)* | | | *MEDPAR (1996)* | | | *HCUP (1996)* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Major Diagnostic Category* | n | *Average Cost* | *Average DRG Weight* | n | *Average Cost* | *Average DRG Weight* | n | *Average Cost* | *Average DRG Weight* | *VA Rank*[a] | *MEDPAR Rank* | *HCUP Rank* |
| 1. Nervous system | 1 | 3,273 | 0.600 | 1 | 3,491 | | 2,044 | 4,091 | 0.822 | 1 | 1 | 1 |
| 2. Diseases of the eye | 1,379 | 4,726 | 0.672 | 435 | 4,339 | 0.706 | 110 | 4,220 | 0.716 | 2 | 2 | 2 |
| 3. Ear, nose, mouth, and throat | 857 | 6,135 | 0.993 | 301 | 5,021 | 1.051 | 1,745 | 4,987 | 1.049 | 3 | 4 | 3 |
| 4. Respiratory system | 4,750 | 6,400 | 1.021 | 6,406 | 4,764 | 0.955 | 498 | 5,835 | 1.078 | 4 | 3 | 4 |
| 5. Circulatory system | 2,333 | 7,592 | 1.179 | 470 | 6,934 | 1.235 | 253 | 8,147 | 1.556 | 5 | 5 | 8 |
| 6. Digestive system | 5,661 | 10,165 | 1.597 | 4,206 | 9,138 | 1.643 | 596 | 10,303 | 1.706 | 6 | 7 | 12 |
| 7. Hepatobiliary and pancreas | 3,018 | 10,926 | 1.378 | 1,189 | 8,266 | 1.638 | 576 | 6,450 | 1.209 | 7 | 6 | 5 |
| 8. Musculoskeletal system | 717 | 11,085 | 1.131 | 210 | 14,049 | 1.131 | 54 | 8,481 | 1.131 | 8 | 15 | 9 |
| 9. Skin, subcutaneous tissue, and breast | 19,288 | 11,361 | 1.706 | 15,085 | 10,051 | 1.873 | 3,644 | 9,164 | 1.295 | 9 | 9 | 10 |
| 10. Endocrine, nutritional, and metabolic | 1,768 | 12,046 | 1.759 | 706 | 9,635 | 1.784 | 225 | 7,641 | 1.693 | 10 | 8 | 7 |
| 11. Kidney and urinary tract | 5,458 | 12,572 | 1.963 | 5,253 | 10,563 | 1.934 | 749 | 15,189 | 2.835 | 11 | 10 | 16 |
| 12. Male reproductive system | 212 | 12,942 | 2.356 | 104 | 13,430 | 2.551 | 43 | 14,849 | 2.911 | 12 | 14 | 15 |
| 13. Female reproductive system | 76 | 13,658 | 2.371 | 93 | 14,290 | 2.371 | 8 | 13,827 | 2.371 | 13 | 17 | 14 |
| 14. Pregnancy and childbirth | 895 | 14,958 | 2.296 | 559 | 12,536 | 2.448 | 119 | 18,644 | 3.531 | 14 | 13 | 19 |
| 16. Blood and Immunological disorders | 3,628 | 15,008 | 2.210 | 3,378 | 11,533 | 2.255 | 912 | 9,622 | 1.999 | 15 | 12 | 11 |

*(continued)*

TABLE 5 (continued)

| Major Diagnostic Category | VA (1998) n | VA (1998) Average Cost | VA (1998) Average DRG Weight | MEDPAR (1996) n | MEDPAR (1996) Average Cost | MEDPAR (1996) Average DRG Weight | HCUP (1996) n | HCUP (1996) Average Cost | HCUP (1996) Average DRG Weight | VA Rank[a] | MEDPAR Rank | HCUP Rank |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17. Myeloproliferative diseases | 11,851 | 15,282 | 2.150 | 7,381 | 14,153 | 2.664 | 1,680 | 10,643 | 2.371 | 16 | 16 | 13 |
| 18. Infectious and parasitic diseases | 1,216 | 15,601 | 1.808 | 684 | 10,989 | 1.978 | 153 | 7,004 | 2.131 | 17 | 11 | 6 |
| 19. Mental diseases and disorders | 4,146 | 17,565 | 2.827 | 2,631 | 15,176 | 2.881 | 435 | 17,419 | 4.153 | 18 | 18 | 18 |
| 20. Alcohol/drug use | 27,207 | 19,610 | 3.323 | 31,201 | 17,713 | 3.658 | 3,415 | 17,026 | 3.652 | 19 | 19 | 17 |
| 21. Injuries, poisonings | 1,071 | 22,234 | 3.554 | 1,216 | 19,005 | 3.554 | 210 | 20,785 | 3.877 | 20 | 20 | 21 |
| 22. Burns | 44 | 25,345 | 4.789 | 9 | 19,600 | 4.789 | 22 | 20,061 | 5.661 | 21 | 21 | 20 |
| 23. Factors influencing health status | 22 | 26,503 | 4.240 | 173 | 30,361 | 4.372 | 81 | 32,782 | 4.414 | 22 | 22 | 22 |

Note: VA = U.S. Department of Veterans Affairs; MEDPAR = Medicare Provider Analysis Review; HCUP = Healthcare Cost and Utilization Project; DRG = diagnosis related group. Dollars are nominal and not adjusted for inflation. Comparison of VA rank to Medicare rank = 27.27 percent agreement, Kappa = .2381, $p < .0001$. Comparison of VA rank to HCUP rank = 18.18 percent agreement, Kappa = .11429, $p = .0011$.

a. Ranked by ascending cost.

TABLE 6 The Cost Regression's Effect on the Variation of the Estimated Costs

| *DRG* | n | *Average Cost* | SD | *Minimum* | *Maximum* |
|---|---|---|---|---|---|
| 14. Specific cerebrovascular disorders except transient ischemic attack | | | | | |
| Cost | 10,534 | 6,829 | 7,587 | 7 | 175,346 |
| Estimated cost | 10,534 | 7,377 | 7,476 | 685 | 147,135 |
| 79. Respiratory infections and inflammations, age older than 17 with complications and comorbidities | | | | | |
| Cost | 7,767 | 7,923 | 8,445 | 16 | 213,967 |
| Estimated cost | 7,767 | 8,210 | 6,423 | 685 | 198,091 |
| 88. Chronic obstructive pulmonary disease | | | | | |
| Cost | 15,428 | 4,786 | 5,525 | 5 | 203,877 |
| Estimated cost | 15,428 | 4,535 | 4,269 | 685 | 128,695 |
| 89. Simple pneumonia and pleurisy, age older than 17 with complications and comorbidities | | | | | |
| Cost | 12,905 | 5,468 | 8,863 | 8 | 662,916 |
| Estimated cost | 12,905 | 5,238 | 4,675 | 685 | 160,280 |
| 127. Heart failure and shock | | | | | |
| Cost | 21,463 | 4,941 | 4,979 | 10 | 109,945 |
| Estimated cost | 21,463 | 5,224 | 4,479 | 685 | 190,673 |

Note: DRG = diagnosis related group. Cost is the Medicare Provider Analysis Review cost-adjusted charges for 1996. Estimated cost is the estimated cost-adjusted charges for fiscal year 1998. Dollars are nominal and not adjusted for inflation.

## USING THE AVERAGE COST DATA

The medical-surgical average cost databases are available for VA researchers. To merge these data with the VA utilization files, researchers need to reconfigure the VA utilization files, as we did to create the database. As an easy-to-use alternative, we created a discharge data set that combines the medical-surgical, rehabilitation, mental health, and long-term care stays and can be easily merged to the VA patient treatment file (main). For more details, see the HERC average cost guidebook (Wagner et al. 2001).

Finally, users should remember that these cost estimates reflect costs listed in the CDR, which does not include the cost of capital financing or malpractice because they are covered by other federal agencies. Therefore, the HERC cost estimates may not be appropriate to use when a health care program requires additional space or affects malpractice claims or when VA costs are compared to those of non-VA providers.

The average cost method assigns the same cost to all inpatient stays with the same demographic and discharge information. Patients with identical observed characteristics are assigned the same cost. It is important to note that it is not always appropriate for researchers to use the average cost data. Although these data were created with cost-effectiveness analysis in mind, if researchers are interested in assessing the cost effectiveness of close substitutes, then these data are likely to be inappropriate unless one of the interventions affects one of the variables in the cost regression (e.g., LOS). When these data are not helpful, micro-costing methods, such as pseudo-bills or direct measurement, would be necessary (see Smith and Barnett 2003 [this issue]).

## CONCLUSION

This article reports on the methods we used to develop a VA cost database for medicine and surgery inpatient care. The cost estimates are generated from a regression model based on MEDPAR data. The regression model does not account for market-level factors or input prices. This strategy reflected our goal of generating long-run average VA costs. In particular, we generated national VA costs by reconciling the estimated costs with the VA national budget. Although we also generated local VA costs by reconciling the estimated costs with local VA budgets, we strongly encourage researchers to use the national cost estimates. The local cost estimates may be appropriate for a sensitivity analysis in a cost-effectiveness analysis. However, variation in local cost estimates reflects local budget allocations, not underlying differences in input prices, market factors, or production efficiency.

With relative ease, these methods could be adapted to estimate the cost of care in other health care systems. An important factor to consider is the data set on which the cost regression is estimated. We used MEDPAR data restricted to VA patients, but researchers could use the 5 percent MEDPAR data set, HCUP data, or other hospital discharge data. Some of these data sets, such as HCUP, do not have all eight independent variables, thus limiting the model's fit. The researchers would need to determine whether the cost estimates should be reconciled to an accounting data set to reflect system-specific costs. As we have discussed above, caution should be used in applying these

cost estimates in a research project. Nevertheless, these methods can produce robust estimates.

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**Commentary**

# Estimation of Encounter-Level Hospitalization Costs: Accuracy of a Multivariate Prediction Model

*Jesse D. Malkin*
*Michael Schoenbaum*
RAND Corporation

Wagner, Chen, and Barnett (2003 [this issue]) rightly identify the U.S. Department of Veterans Affairs' (VA's) historical lack of uniform cost data as an important barrier to economic analyses within the VA. Their article is an important contribution, and the cost estimates they generate should facilitate many types of health services research. At the same time, there are some aspects of their method that may limit the appropriateness of the cost estimates for certain types of analyses. We discuss several such aspects here.

The model estimates costs in the long run, meaning it assumes all costs are variable. In the VA, however, managers often must make decisions that are essentially short run in nature. For example, managers are often unable to close facilities or even buildings due to political constraints. If the model had adopted a short-run perspective (i.e., treating some costs as fixed rather than variable), some of the parameter estimates (for example, the marginal cost of an extra day of hospitalization) would be expected to decline substantially. The reason for this is that fixed costs are high relative to variable costs in the short run (Schwartz and Mendelson 1991, 1994; Taheri et al. 1998, 1999; Taheri, Butz, and Greenfield 2000a, 2000b; Williams 1996; Reinhardt 1996; Roberts et al. 1999).

For truly long-run analyses, in which it is appropriate and important to consider costs that managers consider fixed in the short run, cost estimates using the Wagner, Chen, and Barnett (2003) methodology are likely to play a

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valuable role. Researchers using these data, however, may benefit by referring to several potential limitations of these cost estimates. For instance, the costing method used by Wagner, Chen, and Barnett allocates costs that are considered fixed in the short run to patients in proportion to costs that are considered variable in the short run. While practical and reasonably straightforward to implement, this allocation rule is essentially arbitrary, in the sense that it does not necessarily reflect the true cost of producing different types of medical-surgical hospitalizations. We recognize that there is no obvious way to address this issue using the available Medicare Provider Analysis Review data.

In addition, research suggests that the approach used to generate the cost estimates may be imprecise. Shwartz, Young, and Siegrist (1995) compared costs estimated using the ratio of cost to charge (RCC) method to costs based on relative value units (RVUs), which hospital managers regard as the best available costing methodology (Ashby 1993). The researchers found that RCC-estimated costs differed from RVU-estimated costs by more than 15 percent in more than one-third of patients. They concluded that RCC-estimated costs are "not a good basis for determining the costs of individual patients." In addition, they found that costs estimated using hospital-level RCCs (the approach used by Wagner, Chen, and Barnett 2003) were more weakly correlated with RVU-estimated costs than costs estimated using departmental RCCs.

We note one more issue that may be important for interpreting research using these cost estimates. Wagner, Chen, and Barnett (2003) indicate that they "normalize" their cost estimates to the VA's cost allocation system. While they do not describe the normalization process in detail, we understand it to mean that costs are multiplied by a constant factor so that, when aggregated, the dollar costs across hospitalizations sum to the relevant VA budget allocation. However, this VA budget allocation is not necessarily identical to the aggregate economic cost of producing these hospitalizations. As a result, their derived cost estimates can most appropriately be thought of as relative value weights for different hospitalizations, rather than as estimates of the absolute economic cost of production.

Estimating the cost of hospitalizations based on administrative data is difficult. The method developed by Wagner, Chen, and Barnett (2003) has a number of limitations, particularly for analyses in which a substantial proportion of costs is fixed. On the other hand, the method should be very helpful for decision makers and researchers seeking long-run cost estimates.

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# Average Cost of VA Rehabilitation, Mental Health, and Long-Term Hospital Stays

*Wei Yu*
*Todd H. Wagner*
VA HSR&D Health Economics Resource Center
and Stanford University
*Shuo Chen*
VA HSR&D Health Economics Resource Center
*Paul G. Barnett*
VA HSR&D Health Economics Resource Center
and Stanford University

*This article describes the development of a database for the cost of inpatient rehabilitation, mental health, and long-term care stays in the Department of Veterans Affairs from fiscal year 1998 forward. Using "bedsection," which is analogous to a hospital ward, the authors categorize inpatient services into nine categories: rehabilitation, blind rehabilitation, spinal cord injury, psychiatry, substance abuse, intermediate medicine, domiciliary, psychosocial residential rehabilitation, and nursing home. For each of the nine categories, they estimated a national and a local (i.e., medical center) average per diem cost. The nursing home average per diem costs were adjusted for case mix using patient assessment information. Encounter-level costs were then calculated by multiplying the average per diem cost by the number of days of stay in the fiscal year. The national cost estimates are more reliable than the local cost estimates.*

***Keywords:*** *cost; economic; expenditures; psychiatry; substance abuse; domiciliary; nursing home*

In fiscal year (FY) 1999, the U.S. Department of Veterans Affairs (VA) provided rehabilitation, mental health, and long-term hospital services to 116,438

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veterans. This required approximately 10.5 million inpatient days at a cost of $3.5 billion dollars. Because the VA health care system is an integrated system with its own facilities and staff, no bills are generated for most of the services provided. Therefore, cost information for health care services provided in VA needs to be estimated based on accounting and utilization records (Barnett 1997, 2003 [this issue]).

This article describes the development of a cost database for rehabilitation, mental health, and long-term hospitalizations. The primary objective of establishing this cost database was to provide individual cost information for health services research and evaluation. To create this database, we merged the Cost Distribution Report (CDR) cost data and Patient Treatment File (PTF) utilization data for each FY from FY 1998 forward and then reconciled any inconsistencies. We classified all non–medical/surgical inpatient stays into nine categories: rehabilitation, blind rehabilitation, spinal cord injury, psychiatry, substance abuse, intermediate bed, domiciliary, nursing home, and psychosocial residential rehabilitation treatment program (PRRTP). For each of the nine categories, we calculated both a national and a local (i.e., medical center) average per diem cost. Local costs that exceeded two times the standard deviation of the national costs were identified as a potential outlier with a flag variable. For nursing home care, we adjusted costs for case mix.

This work resulted in the development of a database that is maintained at the VA Austin Automation Center. VA researchers can contact the Health Economics Resource Center (HERC) to access this database (www.herc.research.va.med.gov).

## NEW CONTRIBUTION

This article describes the development of the first national cost database for rehabilitation, mental health, and long-term hospitalizations in the VA. A unique contribution of this database is average per diem costs with case mix adjustment for nursing home care. The article also discusses limitations of and uses for this database. Although this article reflects our work in the VA, the methodology used to develop this database is a good reference for researchers in other integrated health care systems.

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## METHOD

### VA COST DATA

VA accounting records are summarized in the Financial Management System (FMS) database, which has cost information pertaining to the medical service, nursing service, and so forth. Because FMS cannot be directly linked to patient care departments, the CDR was created. Service chiefs are required to estimate staff time spent on different types of patient care. These time allocations are then used to distribute costs from FMS to cost distribution accounts (CDAs) in the CDR. At the end of each FY, costs in CDAs are reconciled with FMS.

We excluded costs from VA facilities that did not provide patient care, such as VA central offices, information service centers, and other VA support facilities. In VA medical facilities, costs of indirect service departments were allocated to direct service departments in the CDR. The CDR, however, distributes indirect costs only to groups of patient care departments. These indirect costs need to be included with the direct costs to provide complete expenditures. We compared several methods of reallocating these indirect costs and found advantages and disadvantages to each (Wagner et al. 2001). Eventually, we reallocated the indirect costs to each department based on its share of total direct costs.

### VA UTILIZATION DATA

VA inpatient care is recorded in the PTF. The PTF characterizes location of care using 76 bedsections, which are analogous to hospital wards in non-VA facilities. For example, nursing home, intensive care, and psychiatric units are assigned to three different inpatient bedsections. Although we could have developed average per diem estimates for each of these 76 bedsections, many bedsections are used interchangeably as they represent similar types of care (e.g., intermediate medicine and geriatric intermediate medicine). Therefore, we grouped the 76 bedsections into 11 categories: medicine, surgery, rehabilitation, blind rehabilitation, spinal cord injury, psychiatry, substance abuse, intermediate medicine, domiciliary, psychosocial residential rehabilitation, and nursing home (Wagner et al. 2001). Since hospital stays in medicine and surgery are relatively short with large cost variations, we developed other methods to estimate costs for those bedsections and reported them in a separate article (Wagner, Chen, and Barnett 2003 [this issue]).

## MATCHING COST WITH UTILIZATION DATABASES

Before matching the PTF and CDR data sets during each FY, we identified VA medical centers that merged during the FY. Mergers during an FY often are reflected in the cost and utilization databases at different times. Therefore, we treated all mergers that happened in an FY as if they occurred at the beginning of the year.

Although there is a formal link of bedsection to respective CDA, the VA does not reconcile these two databases. Therefore, after matching the data, we found that the cost of providing care in a particular bedsection is not always assigned to the corresponding CDA specified in the CDR handbook (U.S. Department of Veterans Affairs 1996, 2000). In these cases, we reallocated utilization to the most relevant cost account. Details on every reallocation can be found in the HERC inpatient average cost guidebook (Wagner et al. 2001).

## COST DETERMINATION

After reconciling the CDR with the PTF, we estimated average per diem costs for each of the nine categories of care by dividing costs by the number of days of care. This was done for stays at the local medical center level, as well as at the national level, resulting in local and national cost estimates for each of the nine categories of care. The costs included facility payments, physician payments, and indirect costs. The notable exception to the method is that the nursing home costs were further adjusted for case mix, which is described below.

Estimating encounter-level costs involved multiplying length of stay in the FY by the average daily rate (local or national). If a patient was admitted and discharged in one FY, then the total cost represents a discharge estimate. Many nursing home and domiciliary stays last many years (decades in some cases). In these cases, total costs represent only the costs incurred in the FY.

VA policy allows patients to leave the hospital for short periods while "reserving" the bed. This practice is most common among patients in nursing home facilities. We chose not to assign costs to these "leave" days. Although the PTF separates these days from the length of stay, it identifies only the total number of leave days during a stay; it does not record when they occurred. For stays that cross FYs, the PTF does not record how many of the leave days occurred in a given year. To consistently adjust length of stay in an FY for leave days, we assumed that leave days were uniformly distributed throughout the stay.

## CASE MIX ADJUSTMENT FOR NURSING HOME COST

Health care costs should reflect resources used. We generally believe that resource use varies with a patient's medical condition. Since 1994, VA nursing home patients have been systematically assessed for resource use by the resource utilization group (RUG) II instrument. We used the assessment data to adjust cost for case mix. RUG II is a validated instrument to measure nursing home residents' resource use (Schneider et al. 1988; Schultz, Ward, and Knickman 1994; Fries 1990; Fries et al. 1989). To adjust costs for case mix, we first estimated an average RUG II score for each nursing home stay and then normalized the average RUG II score at local and national levels.

## AVERAGE RUG II SCORE FOR EACH STAY

VA nursing home patients, excluding those in non-VA community-based nursing homes, are assessed at admission and reassessed twice a year (April and October). Assessments are conducted using the RUG II instrument, and a RUG score is generated to reflect the intensity of resource use. Depending on the date of admission and length of stay, the number of patient assessments varies for each patient. Therefore, we estimated an average RUG score for each nursing home stay.

One limitation with this approach is that the VA does not assess patients at discharge. Therefore, we developed a regression model to estimate a discharge RUG score for any nursing home stay in which the last assessment was taken more than 90 days before the discharge. For the regression, we selected 1,277 nursing home patients whose last assessment was within 30 days of discharge and who had at least three assessments between FY 1994 and FY 1999. When the last assessment was less than or equal to 90 days before discharge, we used the available assessments to calculate an average RUG score. We chose 90 days because it was consistent with the fact that when calculating an average score from two regular assessments, each measures resource use intensity for a span of 90 days. The average RUG score for each stay was calculated by multiplying the RUG score by the number of days associated with each score. More details can be found in the HERC handbook (Wagner et al. 2001).

## LOCAL NURSING HOME COST ADJUSTED FOR CASE MIX

To adjust nursing home costs for the medical center case mix, we first normalized the RUG score of each nursing home stay by dividing its RUG score by the medical center average nursing home RUG score. The medical center average nursing home RUG score was equal to the weighted average of

nursing home stay scores, using the length of stay as the weight. We then calculated the local case mix–adjusted cost for each nursing home stay by multiplying the unadjusted local average per diem cost by its length of stay and locally normalized RUG score. Equations for the case mix index can be found in Wagner et al. (2001).

### NATIONAL CASE MIX–ADJUSTED NURSING HOME COST

Case mix adjusting nursing home costs for the nation was very similar to calculating the local case mix–adjusted costs. We first normalized the RUG score of each stay for all stays in the nation and then calculated the national case mix adjusted nursing home cost by multiplying the unadjusted average per diem cost by its length of stay and its nationally normalized RUG score.

### VARIATION IN LOCAL COSTS

Local nursing home costs varied substantially from $170 to $845 per diem. To examine how much of this variation was due to wage differences and how much was due to variation in case mix, we regressed unadjusted nursing home average per diem cost on wage index, percentage deviation of medical center case mix index from the national average case mix index, and indicator variables for FY 1998 and FY 1999. To adjust wage difference for a medical center, we used the 1997 wage index developed by the Centers for Medicare and Medicaid Services for reimbursing Medicare hospitals that shared the same labor market with the medical center. Comparison of the $R^2$ values between the regression models with and without the wage index is discussed below.

## RESULTS

### NUMBER OF STAYS, AVERAGE PER DIEM COST, AND LENGTH OF STAY

Table 1 summarizes the number of stays, national average per diem costs, and the mean and median length of stay for the nine categories of nonacute inpatient care provided by VA from FY 1998 through FY 2000 (all in year 2000 dollars). Psychiatric care accounted for 42 percent of the stays. Over the 3-year period, the total number of hospital stays for these nonacute inpatient care declined from 311,000 to 289,000, with rehabilitation (rehabilitation and blind rehabilitation) and substance abuse care declining the most.

Average per diem costs varied substantially from $116 (FY 1998) for domiciliary up to $826 for rehabilitation (see Table 1). For most categories, average

TABLE 1 Number of Stays, Average Per Diem Cost, and Length of Stay of Nonacute Inpatient Care: Fiscal Year (FY) 1998 to 2000

| | *Number of Stays* | | | *Per Diem Cost*[a] | | | *Length of Stay*[b] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Category* | *FY 1998* | *FY 1999* | *FY 2000* | *FY 1998* | *FY 1999* | *FY 2000* | M | Mdn | M | Mdn | M | Mdn |
| Rehabilitation | 9,323 | 7,087 | 6,176 | 826 | 969 | 1,021 | 18 | 15 | 17 | 15 | 17 | 14 |
| Blind rehabilitation | 2,100 | 2,063 | 2,071 | 793 | 803 | 863 | 40 | 40 | 38 | 38 | 37 | 37 |
| Spinal cord injury | 8,607 | 8,470 | 8,089 | 765 | 830 | 829 | 40 | 13 | 42 | 12 | 37 | 12 |
| Psychiatry | 131,382 | 126,756 | 123,773 | 526 | 588 | 635 | 19 | 9 | 17 | 8 | 16 | 7 |
| Substance abuse | 27,278 | 21,305 | 16,528 | 553 | 484 | 455 | 13 | 8 | 12 | 8 | 12 | 8 |
| Intermediate care | 50,369 | 55,129 | 48,988 | 408 | 438 | 491 | 25 | 9 | 19 | 7 | 20 | 7 |
| Domiciliary | 23,955 | 24,054 | 25,796 | 116 | 123 | 112 | 127 | 61 | 109 | 54 | 101 | 43 |
| Nursing home care | 45,973 | 47,706 | 48,117 | 269 | 291 | 305 | 167 | 35 | 149 | 31 | 137 | 29 |
| PRRTP | 11,980 | 11,513 | 9,828 | 157 | 166 | 172 | 33 | 25 | 40 | 28 | 43 | 29 |

Note: PRRTP = psychosocial residential rehabilitation treatment program.

a. Costs are in year 2000 dollars.

b. Length of stay was calculated by subtracting the bedsection admission date by the bedsection discharge or transfer date.

TABLE 2 Three-Year Average Per Diem Costs among U.S. Department of Veterans Affairs Medical Centers, Fiscal Year 1998 to 2000

| *Category* | *Number of Medical Centers* | *Mean* | *Median* | *Standard Deviation* | *Minimum* | *Maximum* |
|---|---|---|---|---|---|---|
| Rehabilitation | 48 | 1,074 | 947 | 491 | 286 | 2,659 |
| Blind rehabilitation | 10 | 738 | 774 | 262 | 77 | 1,005 |
| Spinal cord injury | 24 | 859 | 835 | 287 | 410 | 1,560 |
| Psychiatry | 125 | 762 | 716 | 319 | 101 | 2,155 |
| Substance abuse | 59 | 888 | 545 | 1,687 | 95 | 12,096 |
| Intermediate care | 95 | 626 | 500 | 643 | 58 | 6,014 |
| Domiciliary | 42 | 184 | 137 | 287 | 79 | 1,981 |
| Nursing home care | 125 | 312 | 284 | 104 | 170 | 845 |
| PRRTP | 40 | 190 | 166 | 111 | 16 | 521 |

Note: PRRTP = psychosocial residential rehabilitation treatment program. The average cost was calculated after adjustment for inflation by the Consumer Price Index.

per diem costs increased between FY 1998 and FY 2000, even after adjusting for inflation (not shown). The cost increase varied from 8 percent (spinal cord injury) to 24 percent (rehabilitation).

Length of stay was calculated by subtracting the bedsection admission date from the bedsection ending date. This measure of length of stay includes days from previous years and is used to present an accurate picture of length of stay. The median length of stay varied from 7 days for substance abuse to 65 days for domiciliary in FY 1998. Except for domiciliary and nursing home care, in which length of stay declined, length of stay was relatively stable over the 3-year period. Table 1 shows both the mean and median lengths of stay because nursing home and domiciliary care had a few patients with multiyear stays. As a result of these extremely long stays, the average was significantly different from the median. In addition, we excluded those stays (approximately 9 percent) that were not discharged at the end of the FY.

## COST VARIATION

As one might expect, local (i.e., medical center) average per diem costs varied substantially (see Table 2). Variation could be due to geographically determined wage rates or economies of scale. However, the variation might also reflect accounting mistakes or inconsistencies between the PTF and CDR at the medical center level. In some instances, the difference in local costs between the maximum and the minimum was more than tenfold.

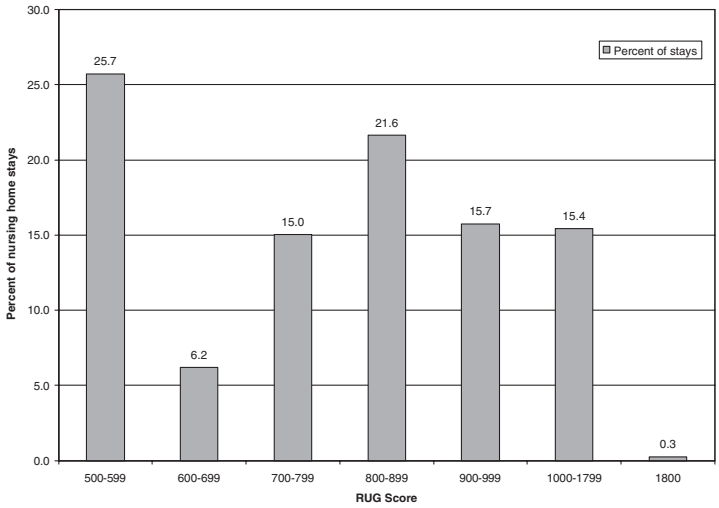


FIGURE 1 Distribution of Resource Utilization Group (RUG) Scores of U.S. Department of Veterans Affairs Nursing Home Stays

## CASE MIX ADJUSTMENT FOR NURSING HOME COST

Costs for nursing homes were adjusted for case mix using RUG II assessments. The national average risk-adjusted per diem cost of a nursing home stay was proportionate to its RUG score because the risk-adjusted per diem cost was estimated by multiplying the national unadjusted average per diem cost (a constant) by the RUG score of the stay. RUG scores reflect the level of acuity of care, ranging from 400 to 1,800. For example, the highest RUG score (1,800) corresponded to patients who were ventilator dependent (0.3 percent of stays). Figure 1 presents the distribution of RUG scores for all the nursing home stays during the 3-year period. Twenty-six percent of the 141,796 nursing home stays had a RUG score less than or equal to 500. More than 30 percent of nursing home stays had a RUG score more than 900, suggesting that these patients obtained relatively more intensive care.

Proportionately allocating cost to a nursing home stay by its RUG score was based on the assumption that all other resources used for nursing home care were distributed in proportion to the level of acuity of care. This was a strong assumption. A recent study showed that RUG III explained only about 10 percent of the variance in total per diem costs (White, Pizer, and White 2002). The limitation of RUGs in explaining the variance does not necessarily mean that RUGs do a poor job of measuring the relative cost of caring for different

TABLE 3 Regression of Nursing Home Case Mix on Nursing Home Average Per Diem Costs, Fiscal Year (FY) 1998 to 2000

| *Independent Variable* | *Estimated Coefficient* | t-*Value* |
|---|---|---|
| Intercept | 230 | 5.78 |
| FY 1998 (versus 2000) | –44 | –2.71 |
| FY 1999 (versus 2000) | –23 | –1.40 |
| 1997 HCFA wage index | 1 | 2.86 |
| Percentage deviation from the national average | 3 | 4.49 |
| $R^2$ = .098 | | |

Note: HCFA = Health Care Financing Administration. The average cost was calculated after adjustment for inflation by the Consumer Price Index.

patients. Per diem costs at different sites, for example, could differ because of fixed costs being spread across a different number of patients, other economies of scale, differences in local wage rates, and different methods of allocating indirect costs among the departments of the hospital. Because these factors did not affect costs consistently, researchers should make adjustments based on their specific studies.

We calculated an average case mix index (RUG score) weighted by the number of days associated with each stay for all 112 medical centers in each of the three FYs. Among the 342 case mix indexes (112 × 3), the mean was 706 and the median was 698 with a standard deviation of 70. The maximum case mix index was 33 percent higher than the mean, and the minimum was 30 percent lower. A regression analysis indicates that 10 percent of the local cost variation was explained by the medical center case mix index and wage index (see Table 3). When the wage index was excluded from the model, the $R^2$ dropped to 7.5 percent (data not shown). For each percentage deviation from the national mean case mix, the average per diem cost deviated by $3. The regression results indicate that most (90 percent) of the cost variation among medical centers is associated with neither wage differences nor case mix.

## DISCUSSION

The primary objective of this study was to develop an encounter-level database from VA cost and utilization data for all rehabilitation, mental health, and long-term inpatient services. The encounter-level estimates reflect all days of stay incurred during the FY. These costs may not reflect a discharge view, as some stays crossed FYs. By reviewing the admission and discharge dates, one

can quickly identify those stays for which we only generate a partial cost estimate.

A unique feature of this database is that it has national representation, large size, and consistent delivery and coverage for health care across medical centers in the nation. Another important feature of this database is that cost for nursing home care has been adjusted for case mix based on an average of multiple assessments during a stay. With care, this database can be used for health services research and by VA management. For example, the shift from inpatient mental health care to outpatient services is reported elsewhere in this issue (Barnett 2003).

As discussed above, the HERC nursing home cost estimates are directly proportional to case mix by construction. Researchers should be aware that some costs (e.g., for capital) are not completely proportional to case mix. About one-third of the Medicare prospective reimbursement rate for skilled nursing homes is not adjusted for case mix. This implies that our method may slightly overestimate the costs for patients with high RUG scores and underestimate them for patients with low RUG scores. However, as capital financing costs are not included in the VA budget, this bias is limited.

With the exception of nursing home care, the average per diem costs are not case mix adjusted. HERC will try in the future to include case mix adjustments to inpatient services for rehabilitation and psychiatric care. Unfortunately, we currently are not able to adjust other types of stays for intensity of care because either no severity measures exist (e.g., psychiatric stays) or the VA does not use the available risk-adjustment measures.

## LIMITATIONS

The cost data described in this article have been put in a database that is available to eligible researchers. To use this cost database appropriately, one must understand its limitations. These cost estimates reflect a merger of data from VA utilization and cost files. The cost data include facility and physician costs but not the cost of capital financing or malpractice. This suggests that the average per diem costs may be low compared to the private sector. Although we do not have exact data on the size of the capital financing and malpractice, we suspect that these may be approximately 5 percent of the cost. Future research will try to determine methods for incorporating these costs.

Although this database may be excellent for descriptive studies, more caution should be used in analytical studies, as these cost estimates may not be sensitive to experimental interventions. For instance, the growth in PRRTP and domiciliary stays reflects a programmatic change at some VA medical centers. A recent study evaluated the adoption of PRRTP care, which is a less

intensive psychiatric and substance abuse program, and found that it was associated with substantial savings (Wagner 2002, 350). In this case, the adoption of PRRTP care had a large effect on costs. However, for many interventions, these cost data may not be appropriate. For example, if an analyst is studying a slightly more expensive treatment that improves a rehabilitation patient's quality of life, these cost estimates may not be sensitive enough unless the treatment affects the production of care, the probability of admission, or the length of stay. In cases in which analysts need more sensitive cost estimates, micro-costing methods are available (Swindle et al. 1999; Barnett, Chen, and Wagner 2000). Although such methods have been used successfully in VA studies, they can be very time consuming and expensive to employ (Smith and Barnett 2003 [this issue]).

Some health care services, particularly for long-term care, are contracted to non-VA facilities. In FY 2000, total contracted services accounted for approximately 7 percent of total VA costs. Because VA does not have accurate cost and utilization data at the encounter level, the HERC Average Cost Database does not include contracted services. For inpatient care discussed in this article (i.e., rehabilitation, mental health, and long-term care), however, encounter-level utilization data are reported in the VA PTF. Therefore, one possibility to estimate costs for contracted inpatient services is to use the average VA costs estimated by HERC in the same category. Another possibility to estimate contracted inpatient services is to use an average reimbursement rate from non-VA sectors such as Medicare.

The HERC rehabilitation, mental health, and long-term care database contains two cost estimates: a national cost and a local medical center cost. In both cases, the encounter-specific costs reflect an average per diem rate times the length of stay. However, the national and local average per diem rates differ. The national rates are calculated by dividing all costs in one of the nine categories (e.g., rehabilitation) by number of days of stay for that category. The local cost estimate uses the same calculation, but it is restricted to stays at a given medical center. The large variation among local average per diem costs suggests that accounting mistakes and inconsistencies are significant in some medical centers. For example, one medical center with $3.2 million for substance abuse costs in FY 1998 provided 282 days of substance abuse care. This yields a very large cost estimate ($12,095 per day), which may be valid or symptomatic of a potential error.

One explanation for this difference is that the PTF and CDR are not officially reconciled, and local accounting differences may be partially to blame. Therefore, we strongly recommend using the national cost estimates for studies that evaluate health care interventions. Researchers may wish to use local costs in a sensitivity analysis but should be cautious to outliers. Extremely

low workload and inappropriate cost allocation are two common reasons for generating average per diem cost outliers. To provide further guidance to researchers, we included a flag variable in the database that identifies a record in which the local cost is greater than two standard deviations from the national cost.

## DATA EVALUATION

Because the HERC Average Cost Database is based on allocated budgets, it may not accurately reflect the true costs of production services. The discrepancies between actual costs and HERC estimated costs could significantly affect study results, especially using the local costs, because budget allocation varies considerably across medical centers. HERC will evaluate this cost database and report the evaluation results to users, but researchers should also evaluate cost data obtained from this database. One evaluation strategy is to compare your costs with the VA national average for similar services. Another method is to compare your costs with that in the non-VA sectors (e.g., Medicare or Medicaid reimbursement rates). When costs are unreasonably high or low, further investigation may be needed. For example, researchers can use the micro-costing method to validate the data in a selected sample. With appropriate evaluation and adjustments, this database will be useful for health care research and management.

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# Estimating the Costs of VA Ambulatory Care

*Ciaran S. Phibbs*
VA HSR&D Health Economics Resource Center and VA Cooperative Studies Program; Department of Health Research and Policy, Stanford University; Center for Primary Care and Outcomes Research, Stanford University
*Aman Bhandari*
Health Services and Policy Analysis Program, University of California, Berkeley
*Wei Yu*
VA HSR&D Health Economics Resource Center and VA Cooperative Studies Program; Center for Primary Care and Outcomes Research, Stanford University
*Paul G. Barnett*
VA HSR&D Health Economics Resource Center and VA Cooperative Studies Program; Department of Health Research and Policy, Stanford University; Center for Primary Care and Outcomes Research, Stanford University

*This article reports how we matched Common Procedure Terminology (CPT) codes with Medicare payment rates and aggregate Veterans Affairs (VA) budget data to estimate the costs of every VA ambulatory encounter. Converting CPT codes to encounter-level costs was more complex than a simple match of Medicare reimbursements to CPT codes. About 40 percent of the CPT codes used in VA, representing about 20 percent of procedures, did not have a Medicare payment rate and required other cost estimates. Reconciling aggregated estimated costs to the VA budget allocations for outpatient care produced final VA cost estimates that were lower than projected Medicare reimbursements. The methods used to estimate costs for encounters could be replicated for other settings. They are*

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*potentially useful for any system that does not generate billing data, when CPT codes are simpler to collect than billing data, or when there is a need to standardize cost estimates across data sources.*

***Keywords:*** *outpatient; cost; price; Medicare; reimbursement; microcost; veterans; VA*

The Department of Veterans Affairs (VA) is one of the largest integrated health care providers in the United States. The VA has extensive utilization databases that use standard coding systems to record the care it provides. Because VA provides care without charge to most eligible veterans, it does not generate patient bills and, until the development of the Decision Support System, has not tried to allocate costs or charges to specific patient encounters. This article reports how the VA Health Economics Resource Center (HERC) used the Common Procedure Terminology (CPT) codes (4th ed.) to estimate the cost of every VA ambulatory care encounter.

The primary study objective was to assign costs to all VA outpatient encounters. For the most part, the methods described here could easily be applied to other studies or to other health systems. For example, there could be research projects with access to CPT code data, but the billing or cost information is not reliable or cannot be obtained without considerable effort. Another potential use is for studies with data collected from multiple systems with different cost estimates for the same CPT codes. These methods could be used to generate a standardized set of cost estimates. A third potential use is for analyses of billing information that reflects charges driven by market imbalances. If a research project needs estimates of actual or economic costs, not charges or payments, the analyst can adapt these methods to generate the necessary estimates.

This study relied on CPT codes, but CPT codes alone do not cover all possible provider services. To address this limitation, we also used the Health Care Financing Administration's Common Procedure Coding System (HCPCS), which was developed to cover medical supplies, devices, and specialized

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services not represented by a CPT code. For ease of notation, hereafter when we refer to CPT codes we mean both CPT and HCPCS codes, except where explicitly noted. Together, these two coding systems comprehensively cover provider and outpatient services.

Despite the use of CPT codes, there was no common set of non-VA payments or cost estimates for all CPT codes. Medicare had a payment rate for many services, yet there were many others that were not covered by Medicare, some of which were commonly used in the VA (e.g., provider consults by telephone). Thus, it was necessary to use multiple reimbursement schedules to establish a unified list of payments or costs for all CPT codes.

Some of the assumptions that we made for this study are appropriate only for the VA (e.g., our assumptions about the VA cost data). Others reflect limitations with the actual data and methods for matching ambiguous codes. We provide examples of some of the decisions that we made to assign a cost estimate to each CPT code used by VA in fiscal year 2000 (FY2000). These examples provide a framework for the logic of developing a comprehensive set of cost estimates for the CPT codes used in a specific setting. Extensive details and methods for FY1998 and FY1999 can be found elsewhere (Phibbs et al. 2001).

We scaled estimated payments to department-level VA costs to obtain cost estimates. To avoid confusion, we use the term *payments* to refer to provider charges or payment rates, including the relative value units used by Medicare. The term *costs* is reserved for payments adjusted to equal actual aggregate VA costs of providing care.

## NEW CONTRIBUTION

There are two new contributions from this article. First, Medicare payment schedules do not include payments for all CPT codes. These exclusions can represent an important portion of the costs incurred by patients. We report on finding cost estimates for the excluded CPT codes. Second, we report on the methods we used to estimate costs for every VA outpatient encounter. One product from this work was a VA ambulatory cost database that can be linked to VA outpatient utilization data. We hope that this database facilitates economics and health services research by those using VA data. Detailed information on these data and how to access them are available in Phibbs et al. (2001). In addition, the lessons we learned could help guide future efforts to find cost estimates for all CPT codes used to measure the care received by groups of patients.

## METHOD

### DATA

Outpatient utilization data were obtained from the VA National Patient Care Data Outpatient Event file (Hynes, Joseph, and Pfeil 2002). VA cost data were obtained from the Cost Distribution Report (CDR). Because the CDR does not track clinic-specific costs, we aggregated the clinics into 13 categories of care that were consistent with the CDR cost distribution accounts. These 13 categories represent broad groups of similar clinics (e.g., all outpatient surgical clinics). Indirect costs reported in the CDR were then allocated to each category in proportion to the direct costs reported in the CDR.

Outpatient pharmacy costs were not included in this database because the pharmaceuticals provided by VA outpatient pharmacies are not reported in the Outpatient Event file. But, the Outpatient Event data do contain information (CPT codes) for pharmaceuticals dispensed during the encounter. Details on how to obtain data on VA outpatient pharmacy costs are described elsewhere in this issue (Smith and Joseph 2003). Prosthetics payments were estimated, but we did not scale these payments to VA costs because the Outpatient Event data does not record all prosthetics distributed by the VA.

### MEDICARE RESOURCE-BASED RELATIVE VALUE SCALE (RBRVS)

We used Medicare payment rates as the primary source for relative values for CPT codes. Medicare provider payments cover not only physician services but include such items as laboratory tests, diagnostic imaging, and medical supplies. Medicare uses the RBRVS to calculate provider payments. RBRVS is based on detailed study of the economic costs of production (Hsiao et al. 1992). The RBRVS equalizes provider payments per unit of time, with adjustments for the amount of training required, associated stress, and practice costs for each service.

Under RBRVS, Medicare calculates payments in terms of relative value units (RVUs). Medicare issues a conversion factor that converts the RVUs to dollars. We used the 2000 Medicare RBRVS schedule as our primary source of RVUs. When 2000 Medicare RVUs were not available due to coding changes, we used Medicare RVUs from previous years. There are separate conversion factors for anesthesiologists and all other providers. The conversion factors used by Medicare are updated annually and are available from Medicare. For 2000, the conversion factors were $17.77 for anesthesiology and $36.61 for all

other providers. For some services, the reimbursement was not set by RVUs and conversion factors but was found in a separate Medicare fee schedule.

The Medicare RBRVS contains three components: physician work, practice expense, and malpractice expense. Medicare geographically adjusts all three components of the RBRVS payment. Given that we were primarily interested in estimating national VA costs, we did not employ these geographic adjustments. These geographic adjustments could be added to our methods for other applications. Also, the VA costs that we used do not include VA's malpractice expenses; this exclusion had a minimal effect on our estimates, as malpractice costs are a very small portion of total Medicare reimbursement.

When outpatient care is provided in a hospital-based clinic or other Medicare designated facility (e.g., ambulatory surgery center, emergency room, or skilled nursing facility), Medicare often reimburses the provider and the facility. When Medicare pays a facility, the physician practice expense is usually reduced. Since the vast majority of VA outpatient care is provided in settings that would qualify for Medicare facility payments, we used the facility-based practice expense and included facility payments in our estimates of costs. Although the payment to an office-based provider is usually greater than the payment to a facility-based provider, the facility receives a separate payment that usually exceeds this difference.

Medicare reimburses providers with a global payment for many procedures (e.g., surgery). This payment covers a bundle of services, such as preoperative care, procedures, and postoperative care. The payment is the same regardless of the number of pre- and postoperative visits. For procedures subject to global reimbursement, Medicare identifies what part of the reimbursement is for performing the procedure and what part is for all other covered services. Bundling payments reduces incentives to provide a larger bill for related services. Our goal was to develop VA cost estimates that reflected actual resource use. Thus, instead of using the Medicare global payment, we unbundled the services. For procedures that Medicare assigns a global payment, we used the payment for the procedure alone and assigned specific costs for each pre- and postoperative encounter. Thus, our estimates reflect variations in resource use associated with different numbers of pre- and postoperative visits.

## GAP CODES AND OTHER FEE SCHEDULES

Many outpatient services provided by VA are benefits that are not covered by Medicare. Examples of these services include some preventive care and telephone contacts. We therefore supplemented the Medicare schedule with other payment methods. To the extent possible, we used sources of payment

data that were consistent with the Medicare payment methodology. The single most important source (17 percent of total CPT codes) of non-Medicare payment information was the Ingenix Corporation (Ingenix 2000), which has the RVUs that have been estimated by the private sector using the Medicare methodology. Because they fill important gaps in the Medicare fee schedule, these codes are often referred to as gap codes.

Some of the sources of payment information or RVUs included payments or RVUs for CPT codes that have Medicare RVUs. This overlap allowed us to rescale the data from other sources to be consistent with the Medicare RVUs. We were able to apply this method to data from the California Workmen's Compensation System (State of California 1999) and a survey of U.S. physicians (Wasserman 2000b). If overlaps were not available, we just used the payments without scaling them to Medicare RVUs. If the data were from a year besides 2000, we used the ratio of Medicare conversion factors to adjust for inflation. This method was applied to the data from the 1999 survey of the American Dental Association (2000), the 1999 survey data from the National Dental Advisory Service (Wasserman 2000a), and the average wholesale price of pharmaceuticals (Medical economics 2000).

## COSTS FOR OTHER CPT CODES

We made a variety of other adjustments to obtain payments for CPT codes that were not matched to a payment by one of the above methods. Obsolete CPT codes were assigned the payment rates and RVUs of the replacement CPT code. CPT codes for services that can be done only on an inpatient basis were assumed to be coding errors and assigned an average payment for the clinic category. Some clinic visits by patients in VA long-term care facilities were coded as inpatient evaluation and management (E&M) services. These visits were assigned payments using time and complexity to match them to the corresponding outpatient E&M codes. Pediatric codes that had an adult equivalent were assigned the RVU of the adult code, for example, vaccines that have separate codes for pediatric and adult doses. Codes for pediatric and obstetric services not provided by VA were assigned the average VA payment per CPT code for the clinic category.

Each group of CPT codes includes a code for unlisted service or procedure. These codes are widely used by the VA. To estimate an RVU, we applied the weighted average payment for similar procedures. For example, we calculated the payment for unlisted hematology and coagulation procedures as the weighted mean payment of hematology and coagulation procedures actually performed by the VA.

We next reviewed any codes used by VA more than 100 times to try to identify a similar service with a payment rate. To check the validity of this matching to similar services with payment rates, we had at least one member of the HERC Clinical Advisory Panel review all matches. The remaining codes were assigned the national average payment per CPT code for each of the 12 categories of care we defined from the VA accounting data. Before assigning these average payments, each CPT code was reviewed to determine whether it was appropriate to assume that the service should be assigned the average payment. This review was done regardless of the number of times VA used the code, including codes used very infrequently. We considered whether these services were very expensive (e.g., custom, motorized wheelchair) or very inexpensive (e.g., a disposable syringe). When we deemed it inappropriate to assign an average payment to a service, we obtained a recommendation from a member of our clinician advisory panel about what constituted a similar service, and used the associated RVU.

## MEDICARE AMBULATORY PAYMENT CLASSIFICATIONS

After developing an RVU for every CPT code, we identified the CPT codes that should be assigned a facility payment. Medicare adopted a new, prospective method of paying ambulatory care facilities in August 2000. This method assigns CPT codes to Ambulatory Payment Classifications (APC). A facility reimbursement was assigned to each APC. For services that were not covered by Medicare, we extended the Medicare method to estimate the appropriate facility payment.

Medicare assigned CPT codes representing similar services with similar facility costs to APC groups. Our primary sources of payment rates were the rules from 2000, the 1st year in which Medicare used the APC to calculate facility payments, and the new APC categories created for 2001. In general, when a visit involves several CPT codes, the facility receives an APC payment for each code. The exception is that APC payments for many surgical procedures are reduced by 50 percent unless the procedure is the largest APC payment for the visit.

Under the Medicare rules, many types of care are not eligible for facility payments. Procedures where the facility reimbursement comes from the APC payment for another CPT code do not receive a separate facility payment (e.g., facilities do not receive an APC payment for anesthesia CPT codes, since the anesthesia component of the facility payment is included in the APC associated with the procedure). Services covered by some specific Medicare fee schedules do not have a separate facility payment because the facility payment is included with provider reimbursement (e.g., laboratory tests, dialysis,

and medical supplies). Procedures that can be provided only in an inpatient setting are also not eligible for facility payments as these costs are covered by the inpatient hospital payment.

The VA provided many services that were not covered by Medicare and have not been assigned an APC. We first considered whether a facility payment was appropriate. If it was, we followed the methods we used for provider payments; for example, new CPT codes to replace obsolete codes and weighted averages for the unlisted procedures. We then considered if there was a similar procedure that had an APC payment. For example, Medicare reimburses facilities for some types of imaging tests but not others. When this occurred, we assigned the APC payment for the similar service and had a clinician review it. Codes that were assigned the average provider payment were also assigned the national average facility payment.

For services that could not be assigned a facility payment by these methods, we approximated one using the RBRVS practice expense payments for office-based providers. This included gap-code services and services characterized by codes that became obsolete by the time the APC system was implemented. We multiplied the office-based practice payment (the higher RVU payment for services provided in an office-based setting, as compared to a facility) by a factor that reflects the higher payments to facilities. We found this factor by comparing Medicare's APC facilities payments to the relevant office-based practice expense payments. We used the median ratio of these payments, 2.2, as our adjustment factor. The application of this method was limited to services that could be provided in office-based settings.

## RECONCILIATION WITH VA ACCOUNTING COSTS

Once we had assigned provider and facility payments to each CPT code used by the VA, we applied them to all VA outpatient encounters. Within each category of care, we summed these estimated payments and compared them to the VA's reported costs from the CDR. The ratios of aggregate estimated payments to actual VA costs were used to scale the estimated payments so that our estimated costs within each category of care equaled the VA's actual costs for all care provided in each category. We refer to these estimates as our national cost estimates because the estimated costs for each procedure are uniform across all VA facilities.

Some VA researchers may need local, not national costs, so we created a second set of cost estimates using VA costs to account for geographic variations in production costs. To do this, we summed the national cost estimates for each VA facility and scaled them so that they equaled the total CDR outpatient costs at each facility. In using VA facility-specific costs to adjust for regional

variation, we have assumed that this is a better adjustment for regional cost variation for VA than the regional adjustment factors used by Medicare for wages, other practice costs, and malpractice costs. Conversely, using the costs at each local VA for regional adjustments means that they could also include facility-specific differences such as using different combinations on labor inputs to produce the same procedure. All three estimates (Medicare payment, VA national costs, and VA local costs) are available to researchers with access to the national VA computer center. Complete details on these data for each year and how VA researchers can access them are available in Phibbs et al. (2001).

## ASSUMPTIONS MADE IN ASSIGNING COSTS TO CPT CODES

It was not possible to assign payments to all of the CPT codes used by VA without making a series of assumptions. The major assumptions included the following:

*1. All ambulatory care is comprehensively characterized by the CPT codes used in the national VA outpatient events database*. We assumed that the CPT codes recorded in VA outpatient databases accurately reflect the outpatient care VA actually provided and that no additional services were provided by VA. Implicit in this is the assumption that VA coding of CPT codes was the same as it was in Medicare so that the services represented by each CPT code are the same.

*2. All CPT codes used by VA represent a service that should be assigned a cost*. Many of the CPT codes used by VA would be rejected by third party payers in the private sector. For example, telephone care, follow-up surgical visits, and services assigned nonspecific procedure codes are not separately covered by Medicare. Rather than taking a payer's perspective, we assumed that every code used by VA represented a service that should be assigned a cost.

*3. Costs are proportionate to payment rates*. We assumed that VA cost of providing ambulatory care was proportionate to the estimated Medicare payment associated with each CPT code. We used Medicare reimbursement schedules, supplemented with selected private sector or other government reimbursement schedules for services not covered by Medicare.

*4. Some of Medicare's reimbursement methods were not appropriate for VA*. We calculated a national average Medicare payment, without applying geographic adjustments for local market wage differentials. We did not use the

Medicare established global payments for surgical services. Instead, we broke these down to a specific payment for each service covered by the global rate, (e.g., we found the separate payments for surgeries and follow-up visits). We assigned payments to services that would not be reimbursed separately by Medicare.

*5. Nonstandard service codes represent valid costs*. Some CPT codes used by VA are not normally used to prepare outpatient bills in the private sector. These include codes for procedures that are provided only to inpatients, codes that are obsolete, and codes that are not sufficiently specific to be accepted by third party payers. We assumed that these codes represent a service provided by VA. Due to insufficient data, we were forced to use assumptions to estimate the payments for this care.

*6. Payments should include facility payments*. Because most VA care is provided in a setting that meets the Medicare definition of a facility, we included facility payments. Medicare defines a facility as a hospital-based clinic, a skilled nursing facility, a freestanding surgery center, a comprehensive outpatient rehabilitation facility, or a community mental health center. This assumption increased the estimated payments and VA costs for those VA ambulatory care encounters provided in facilities that were not eligible for a facility payment. Note that this also assumes that the Medicare facility payments accurately reflect the facility costs incurred by VA.

*7. VA incurs the cost of ambulatory care reported in the CDR*. We used the CDR to adjust the resulting relative payments to VA total costs at the medical center and national levels. We assumed that outpatient care costs listed in the CDR were comprehensive and valid. To create our national cost estimates, we assumed that the total national cost of providing VA ambulatory care in each of 11 categories of care was as reported in the CDR. The same assumption was made for the local or medical center level aggregation.

*8. Indirect costs are incurred in proportion to direct costs*. We distributed the indirect cost of ambulatory care reported in the CDR to different types of ambulatory care. We used direct cost as the basis of this distribution.

*9. The CDR distribution of costs between inpatient and outpatient is accurate at each individual medical center*. To create our local cost estimates, we assumed that the total cost assigned to ambulatory care at each medical center was accurate. However, we did not assume that the cost reported in each category of care at each medical center was accurate. The local cost reflects national and local distribution of costs.

## RESULTS

In FY2000, VA employed more than 9,000 different CPT codes to characterize more than 100 million services and procedures provided. Table 1 characterizes the VA outpatient care by the source of the HERC payment estimate. The 2000 Medicare RBRVS and Ingenix gap codes were the payment source for 77 percent of the CPT codes that accounted for 90 percent of the procedures and 85 percent of the estimated payments. In results not shown, we calculated that the Medicare RBRVS was accounted for 61 percent of the CPT codes representing 82 percent of the procedures and 77 percent of the estimated payments. Another 17 percent of the CPT codes used by VA were characterized by nonstandard use of CPT codes; these accounted for 8 percent of the services provided, and 9 percent of the costs incurred by VA.

The bottom portion of Table 1 summarizes how we addressed the VA's use of nonstandard of CPT codes. It gives the number of VA services represented by nonstandard codes, the number of problem codes, and the total provider payment that we assigned to these codes. The relative importance of these problem codes depends on frequency of use. The Other Inpatient Codes was the most frequent type of coding problem in terms of number of codes, but they were rarely used. Thus, there was very little cost associated with this type of coding problem. Conversely, unlisted procedures codes are only about 9 percent of the nonstandard codes, but 60 percent of their occurrences and 40 percent of their costs.

Table 2 provides a breakdown of the different ways that CPT codes were matched to APC payments. Under the Medicare payment rules, surgical codes for a single encounter are subject to discounting; only the most expensive procedure is assigned full facility payment, and additional procedures receive half-payments. Although there were more codes subject to discounting than not, the codes that were not subject to discounting were used much more frequently. For FY2000, VA used 1,424 CPT codes with APCs that were not eligible for discounting for 43.7 million procedures, but used the 2,836 CPT codes that were eligible for discounting only 2.0 million times.

Given the types of services where facility payments are not appropriate (e.g., lab tests), there were many codes (3,572) with no APC-based amount, and they were heavily used (44,339,798 procedures). Of the CPT codes for which Medicare did not assign an APC-based facility payment, our use of gap code facility payments was the most common method to estimate an APC payment. This method was used for 171 CPT codes, representing 14,591,338 procedures.

Table 3 identifies the HERC estimated payments using Medicare payment rules and compares them with the VA CDR costs, by VA clinic category. As

TABLE 1 VA Utilization by Source of HERC Provider Payment Data (FY2000)

| | *Number of CPT Codes Used* | *Number of VA Outpatient Procedures* | *Total of Provider Payment ($)* |
|---|---|---|---|
| Source of payment | | | |
| Medicare 2000 RBRVS or Ingenix gap codes | 7,223 | 96,346,965 | 3,178,538,771 |
| Medicare RBRVS or Ingenix, other years | 56 | 5,352 | 391,684 |
| Other Medicare fee schedules | 24 | 7,031 | 1,115,379 |
| Dental charge surveys | 440 | 2,385,223 | 199,833,497 |
| California Worker's Compensation System | 7 | 674 | 13,771 |
| Physician charge surveys | 10 | 245,960 | 12,201,892 |
| Redbook | 64 | 25,946 | 10,496,252 |
| Nonstandard codes | 1,579 | 8,229,765 | 350,594,550 |
| Total | 9,403 | 107,246,916 | 3,753,185,796 |
| Resolution of coding problems | | | |
| Unlisted procedures | 145 | 4,907,750 | 141,539,668 |
| Obsolete codes | 43 | 288,903 | 11,733,110 |
| Inpatient E&M codes | 32 | 162,299 | 6,043,538 |
| Other inpatient codes | 922 | 8,766 | 781,577 |
| Pediatric codes changed to adult equivalent | 32 | 75,539 | 757,042 |
| Clinically similar code | 144 | 1,315,495 | 24,502,288 |
| Clinically similar payment | 45 | 1,412,489 | 160,019,328 |
| Pediatric/obstetric services not provided by VA | 33 | 145 | 12,928 |
| Remaining services assigned average payment | 183 | 58,379 | 5,205,072 |

Note: VA = Veterans Affairs; HERC = Health Economics Resource Center; FY = fiscal year; CPT = Common Procedure Terminology; RBRVS = Resource-Based Relative Value scale; E&M = evaluation and management.

TABLE 2 Facility Component of Payment by Source (FY2000)

| *Source of Payment* | *Number of CPT Codes Used by VA* | *Number of VA Outpatient Procedures* |
|---|---|---|
| Medicare 2000 APC payments subject to discounting | 2,836 | 1,982,048 |
| Medicare 2000 APC payment not subject to discounting | 1,424 | 43,699,342 |
| Codes with no APC payment | 3,572 | 44,339,498 |
| Matched to similar CPT code | 107 | 387,898 |
| Ingenix gap codes | 171 | 14,591,338 |
| Medicare 1997 | 18 | 2,771 |
| Unlisted procedures | 7 | 437,600 |
| Obsolete codes | 101 | 1,576,832 |
| Inpatient E&M codes | 32 | 162,299 |
| Remaining services assigned average facility component of payment | 1,138 | 67,290 |
| Total | 9,406 | 107,246,916 |

Note: FY = fiscal year; CPT = Common Procedure Terminology; VA = Veterans Affairs; APC = Ambulatory Payment Classifications; E&M = evaluation and management.

noted above, we did not estimate Medicare payments for services provided by the outpatient pharmacy or prosthetics categories of care, and these services account for about a third of all VA outpatient costs. In aggregate, for those categories we can match to utilization data, the VA's accounting costs were 24 percent lower than our estimated Medicare payments. As explained above, these estimates do not reflect actual Medicare reimbursement; we did not apply all of the Medicare payment rules, we assigned payments to services provided by the VA that Medicare does not cover, and we assumed facility payments for all VA facilities. The relationship between our estimated Medicare payments and the VA CDR costs varied considerably across the categories of care, with VA costs being much lower for all services except medicine, adult day care, and home care. The VA CDR costs were marginally lower than estimated Medicare payments for adult day care, marginally higher for medicine, and much higher for home care.

## DISCUSSION

We used Medicare and other private sector payment rates as relative values to estimate the actual VA costs of outpatient care across patient encounters by CPT code. Although our estimates show that the VA's costs were 24 percent lower than estimated Medicare payments, the actual difference was almost certainly less due to some of the assumptions we made. We assigned costs to all services provided by the VA even though Medicare and other private sector insurers would not actually provide payment directly for at least some of these services. We also assumed that all VA outpatient encounters would be eligible for a Medicare facility payment, and facility payments accounted for almost half of our estimated payments. While we believe that most VA outpatient services would be eligible for a facility payment, we did not actually apply the Medicare rules to each VA facility. It is almost certain that some of the VA outpatient encounters do not qualify for facility payments. Because they were based on private sector charges instead of estimated costs or actual payments, it is also likely that our estimated dental payments are higher than they should be, as private sector charges almost always exceed costs and payments.

A careful comparison of VA costs and Medicare payments is beyond the scope of this study. A comprehensive review of the literature comparing VA and non-VA health care costs found that there was some indication that VA costs were lower than private sector charges, but that there was no conclusive evidence to support any differences in costs. This study also noted that institutional differences across systems made these comparisons difficult (Hendricks, Remler, and Prashker 1999). A recent VA study that looked in detail at the differences between VA costs and Medicare reimbursement for six

TABLE 3 VA Accounting (CDR) Costs and HERC Estimated Payments for VA Outpatient Services, by VA Clinic Category (FY2000) (in dollars)

| *VA Clinic Category* | *VA Accounting Costs* | *HERC Estimated Total Payment* | *HERC Estimated Provider Payment* | *HERC Estimated Facility Payment* |
|---|---|---|---|---|
| Medicine | 2,310,789,310 | 2,096,818,942 | 964,306,648 | 1,132,512,294 |
| Dialysis | 97,494,620 | 149,070,979 | 42,909,464 | 106,161,515 |
| Ancillary services | 195,494,112 | 313,859,001 | 141,721,333 | 172,137,668 |
| Rehabilitation | 264,348,590 | 359,648,194 | 196,917,655 | 162,730,539 |
| Diagnostic | 759,051,648 | 1,556,210,292 | 967,741,902 | 588,468,390 |
| Surgery | 758,737,263 | 998,079,173 | 413,704,973 | 584,374,200 |
| Psychiatry | 599,024,008 | 1,007,123,329 | 518,944,878 | 488,178,451 |
| Substance abuse | 182,696,246 | 318,600,112 | 134,941,218 | 183,658,894 |
| Dental | 186,487,626 | 315,035,797 | 264,660,192 | 50,375,605 |
| Adult day | 10,224,767 | 11,306,518 | 5,873,873 | 5,432,646 |
| Home care | 173,086,964 | 72,786,410 | 44,434,690 | 28,351,720 |
| Pharmacy | 2,652,165,809 | | | |
| Prosthetics | 265,552,185 | | | |
| Total, excluding pharmacy and prosthetics | 5,537,435,154 | 7,260,487,134 | 3,741,186,191 | 3,519,300,943 |

Note: VA = Veterans Affairs; CDR = Cost Distribution Report; HERC = Health Economics Resource Center; FY = fiscal year. Total VA accounting costs, including pharmacy and prosthetics, is $8,455,153,148.

VA facilities reinforced these conclusions (Nugent and Hendricks 2003). Accurately determining if VA health care costs less than Medicare payments will require additional research.

Our estimates do not include the costs of outpatient pharmacy, which are almost one third of total VA outpatient costs. While it is possible to assign costs to the VA pharmacy benefits, they cannot be compared with Medicare payments as Medicare does not cover most outpatient pharmacy costs. While they are not included in our comparison of VA and Medicare, VA pharmacy costs are certainly lower than private sector costs as the VA pharmaceutical costs are among the lowest in the nation.

The estimates of prosthetics costs were limited to payments; we did not scale these payments to VA costs. The reason for this was that the prosthetics costs reported in the CDR greatly exceeded estimated payments, which clearly indicated incomplete data. Scaling the payments for the prosthetics that were reported in the Outpatient Event data would have caused significant overstatement of these costs for individual patients.

Table 3 shows that there is considerable variation across clinic categories in the differences between VA accounting costs and the HERC estimated payments. The largest relative differences were that VA costs were more than twice as large as HERC estimated payments for home care and that VA costs for the diagnostic category were about half as large as the HERC estimated payments. Furthermore, the VA costs for most of the other categories of care were much less than the HERC estimated payments. There were several factors besides actual differences in production costs that could contribute to these differences. First, the allocations of VA accounting costs could have errors in them; this could especially affect the estimates for smaller clinic categories, such as home care. Second, there was variation across clinic categories in the proportion of services provided that were covered by Medicare, and some of the payment assignments for non-Medicare services were less precise. Psychiatry, substance abuse, and home care were three of the clinic categories with proportionately more services not covered by Medicare.

The differences between VA accounting costs and the HERC estimated payments on Table 3 also indicate two limitations in the use of our VA cost estimates. First, our estimates are probably more accurate for the aggregate of all types of services used than they are for specific types of services. If a researcher is only using our VA cost estimates for a small subset of related services, the investigator should probably compare our cost estimates with other sources. A second caveat applies if one is looking at groups of patients that have large differences in the use of particular services, especially if those services are not eligible for Medicare payment. Conversely, these differences should not have

a measurable effect if one is looking at all health care utilization for large cohorts of patients.

Our results show that it is necessary to move beyond Medicare payments to obtain estimates of the relative costs of all outpatient provider services; failure to do so will result in missing data for a significant proportion of outpatient care. In VA in 2000, about 40 percent of the CPT codes, representing about 20 percent of the procedures and 25 percent of the payments, had CPT codes that did not have a Medicare payment. The Ingenix gap codes were an important data source, providing 17 percent of the codes and 8 percent of both the procedures and payments. While the exact proportions may vary across health care systems, it is likely that CPT codes that do not have established Medicare payments will represent a significant proportion of the care received by most cohorts of patients.

The extent to which other sources of cost or payment data need to be considered will vary by the source of the CPT code data and the study design. When the nature of the study requires greater precision of the cost estimates, more care is needed, and it is likely that more sources of cost or payment data will be needed. We found that a relatively small number of CPT codes provide payment information for most of the encounters that are not included in the Medicare and gap payment files. Since we used average payment values for those CPT codes we could not match to payments, we also carefully checked each CPT code to make sure that this was a reasonable assumption. Failing to make these checks would have little effect on the aggregate estimates for the entire VA or for large cohorts of patients, but they could easily lead to large errors in the estimated costs for individual patients.

As we have noted above, we made many assumptions in assigning costs to every VA encounter. Some of these assumptions had very little effect, while others were quite important. For example, our assumption that CPT codes for pediatric and obstetric services not covered by VA were coding errors had little impact, as these codes were used only 145 times (out of more than 100,000,000 procedures). Conversely, most encounters were affected by the assumptions that the RVUs for each CPT code were the same for VA and Medicare and that scaling these RVUs to VA accounting costs yields an accurate estimate of VA costs of providing each service. Our logic was that the Medicare RVUs are probably the best available estimate of the RVUs for each service and thus the best method of allocating VA costs across encounters.

We used large aggregations of VA outpatient care units to minimize the effects of accounting errors. We did not have the data to address the accuracy of the accounting data or if there were systematic differences in how VA records CPT codes compared to the private sector. Our estimates were also

affected by our assumption that costs should be assigned to every CPT code recorded in the VA outpatient data. We assumed that when a CPT code was recorded, some service was provided and costs were incurred.

Cost estimates from the VA's Decision Support System (DSS), the VA's implementation of a commercial hospital accounting system, may provide information on the accuracy of the CDR assignments of costs. Care must be taken in directly comparing our estimates of encounter level costs with those from the DSS; however, the DSS and CDR have different methods of allocating overhead costs, which can significantly affect the estimates (Finkler 1982). We also know that there are significant differences between the DSS and CDR in the number of encounters and in the total direct costs assigned to outpatient care (Yu and Barnett 2002).

In applying this approach to settings besides VA, there will undoubtedly be differences in some of the details and the relative magnitude of problems encountered. Some of these may be unique to the VA; about half of the uses of nonstandard codes were unlisted procedures codes. We know from follow-up with the VA Health Information Management Systems office that most unlisted procedures codes were due to incorrect coding of laboratory tests. This would not be an issue in a setting that was actually billing for these procedures, as payors would require the correct coding before processing the bills. In other systems where CPT codes are assigned but the CPT codes are not used for billing purposes, inconsistencies with billing rules are much more likely. While use of CPT code data that are used for processing payment should eliminate problems such as the use of unlisted procedures, obsolete codes, and the use of inpatient CPT codes for outpatient services, most of the other issues we encountered should apply to any source of CPT code data.

There are other issues that we did not need to consider that may be relevant for other uses of this method. For example, the VA CPT code data come from a single source from a very large health care system with a fair degree of top-down management. While there are almost certainly local variations in how encounters are assigned to CPT codes, the incentives that may influence coding are constant across the entire VA. This does not necessarily apply to data gathered from the U.S. health care system as a whole.

It is a reasonable conjecture that there are systematic differences in how encounters are assigned CPT codes in settings with different economic incentives. Consider the differences in the incentives for a physician assigning CPT codes for outpatient encounters between a physician in solo, fee-for-service practice, a physician in a small group practice, a physician in a large group practice, and a salaried physician working for a large HMO. While a standardized payment for each CPT code will solve the problem of different payments

or estimated costs for the same service across these very different types of providers, the investigator may need to look for systematic differences in CPT coding for similar services.

HERC will continue to create these estimates of the costs of all VA ambulatory care on an ongoing basis. Over time it is our intention to refine the methods outlined above, with a focus on limiting the use of provider charge surveys and the number of CPT codes that have to be matched to another code or assigned to a clinic type average cost. For example, for the 2001 estimates we have been able to identify Ingenix RVUs for most dental services, Medicare payments for many more types of durable medical equipment, and actual VA costs for many pharmaceuticals. It is also our intention to compare these estimates with cost estimates from the DSS. As we noted above, care must be taken in comparing cost estimates from both sources due to the differences in how the data were constructed. The ongoing improvements in the HERC estimates of the costs of VA outpatient encounters, and HERC's planned comparison of its cost estimates with those from VA DSS data as well, will result in better information on the costs of VA outpatient care. These efforts should make it easier for VA researchers to assign costs to outpatient care and have a better understanding of the reliability of these cost estimates.

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# Direct Measurement of Health Care Costs

*Mark W. Smith*
Health Economics Resource Center and Center for Health Care Evaluation, Veterans Affairs Palo Alto Health Care System
*Paul G. Barnett*
Health Economics Resource Center and Center for Health Care Evaluation, Veterans Affairs Palo Alto Health Care System; Department of Health Care Policy, Stanford University

*Cost identification is fundamental to many economic analyses of health care. Health care costs are often derived from administrative databases. Unit costs may also be obtained from published studies. When these sources will not suffice (e.g., in evaluating interventions or programs), data may be gathered directly through observation and surveys. This article describes how to use direct measurement to estimate the cost of an intervention. The authors review the elements of cost determination, including study perspective, the range of elements to measure, and short-run versus long-run costs. They then discuss the advantages and drawbacks of alternative direct measurement methods such as time-and-motion studies, activity logs, and surveys of patients and managers. A parsimonious data collection effort is desirable, although study hypotheses and perspective should guide the endeavor. Special reference is made to data sources within the Department of Veterans Affairs (VA) health care system.*

***Keywords:*** *cost and cost analysis; cost-benefit analysis; research design; data collection*

A challenging element of cost-effectiveness analysis is the proper measurement of costs. Cost data typically come from the financial records of providers or insurers, but such administrative data are not sufficiently accurate for all studies. For example, costs borne by patients and unpaid caregivers are not

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represented. Administrative data also do not give the cost of innovative treatments and may not be sensitive to changes in resource use caused by an intervention. Moreover, data from one provider or insurer do not capture activities of other providers and insurers.

When administrative cost data will not suffice, researchers frequently employ direct methods of measuring cost, gathering data through surveys and observation. This article describes these methods, with examples from the health care system of the U.S. Department of Veterans Affairs (VA). It begins with a brief overview of cost determination elements, including the choice of perspective and the need to measure all economic costs. The second section describes methods for direct measurement of the use and cost of staff, supplies, equipment, and capital. A discussion follows of methods of surveying patients to find costs that they incur and the cost of care obtained in other health care systems. We then discuss characteristics of measurement such as accuracy, precision, and validity. The final section compares methods, offers guidance on their appropriate use, presents a brief discussion, and lists areas for further research.

## NEW CONTRIBUTION

Although direct measurement methods are commonplace, there has been little guidance on using them. Direct measurement has been used in VA studies of mental health (Rosenheck, Neale, and Frisman 1995), geriatric management (Toseland et al. 1997), research (Barnett and Garber 1996), and home-based primary care (Hughes et al. 2000). An earlier overview of VA cost methods briefly describes direct measurement but provides little detail and no guidance on which methods are best (Barnett 1999). The federal task force on cost-effectiveness analysis described direct measurement of health care costs, but its report was not systematic and did not provide application to VA resources (Gold et al. 1996). To our knowledge, this is the first article to compare methods of direct measurement of health care and to offer specific guidance for their use in VA.

## CONSIDERATIONS IN COST DETERMINATION

Since the choice of method depends on the range of costs to be measured and the perspective of the study, we first review some considerations that will affect the method and outcome of a cost analysis that uses direct measurement.

## PERSPECTIVE

The perspective is the economic viewpoint from which an analysis is done, and it dictates the range of cost elements to include. Alternative perspectives include those of society, public payers, the VA, insurance companies, providers, and patients. The relation between perspective and cost elements is illustrated in Table 1, which shows cost elements that must be considered from the perspectives of society, the provider/payer (e.g., VA), and the patient. Luce et al. (1996) describe additional perspectives.

The top row of Table 1 relates perspective to costs that must be counted. From the patient's perspective, for example, only out-of-pocket payments for medical care are considered. A payer such as VA records the payments it makes for covered services, but not costs borne by others (e.g., the patient's out-of-pocket expenses or Medicare payments). Payments by all parties are included from society's perspective.

## LONG-RUN COSTS

Many costs of an intervention vary with the number of people served. These may include medications, medical supplies, and staff time spent on direct care. Other elements such as administrative structures and capital (land, mortgages and leases, utility contracts, etc.) are fixed over a short time horizon. Even these costs may vary over the long term, however. A cost-effectiveness analysis that takes a long-term view must therefore estimate the change in administrative and capital costs that may accrue due to the intervention.

Consider the introduction of second-generation antipsychotics in the 1990s. VA patients using certain drugs in this class have substantially fewer inpatient days than do other patients (Rosenheck et al. 1999; Fuller et al. 2002). In the long run, this difference in inpatient utilization could lead to a reduction in inpatient psychiatric beds, thereby reducing the capital cost of psychiatric care. Other services may be affected as well. In the case of atypical antipsychotics, overall staffing levels may remain constant because the reduction in inpatient days is partly offset by an increase in outpatient visits.

Estimating a long-run effect requires assumptions of clinical impact and projections of future caseloads and costs. There would be two types of costs to estimate: (1) direct, pertaining to clinical staff time, space, and materials; and (2) indirect, the same inputs from administrators. A reasonable source for clinical and staffing projections would be clinicians and managers in the affected units. In VA, the cost of administrative time may be assessed directly through

TABLE 1 Cost Elements under Alternative Perspectives

| *Cost Element* | *Societal* | *Veterans Affairs* | *Patient and Patient's Family* |
|---|---|---|---|
| Medical care (total cost) | All costs | All covered costs | Out-of-pocket payments |
| Patient time for treatment | All costs | None | Patient's opportunity cost |
| Paid caregiving | All costs | All covered costs | Out-of-pocket payments |
| Unpaid caregiving | All costs | None | Opportunity cost of caregiver time |
| Transportation and nonmedical services | All costs | All covered costs (if any) | All costs |
| Sick/disability leave, transfer payments | Administrative costs only | Amount paid + administrative costs | Amount received (negative cost) |

Source: Adapted from Luce et al. (1996), Table 6.1.

existing data sets. In other organizations, it may be necessary to use a survey to estimate the total labor cost (wages plus benefits) of administrators.

A second long-term consideration is the pricing of products used in the intervention. Some interventions, particularly those in the arena of medical technology, lead to patented products and services. In these cases, the long-term cost of adopting the intervention includes paying a royalty (Garber 2000). The prices of similar patented products offer a basis for estimating the total cost. The supplies required for an intervention (e.g., drugs, medical devices) may become less expensive if an intervention is adopted widely as manufacturers increase supplies of the needed products.

Clinical efficiency can also affect the cost of an intervention. The average cost of the intervention may fall over time as clinicians become more practiced at performing it (Rosenheck, Neale, and Frisman 1995). Clinicians in specialized facilities may be more efficient at providing care than those at typical hospitals and clinics. Finally, there may be returns to scale in providing an intervention as methods of care are adjusted within a facility. If this happens, long-run costs will fall below short-run costs measured during the study. As analyzing this is a venture into the hypothetical, sensitivity analysis can play an important role in facilitating the optimal use of the findings.

## SCOPE OF MEDICAL COSTS

The range of items needing direct measurement will be affected by the impact an intervention has in other areas of medical care. For instance, prescribing clozapine for treatment-refractory schizophrenia patients was shown to reduce inpatient costs considerably relative to the use of older antipsychotics (Rosenheck et al. 1999). Thus, research on pharmaceuticals should track all types of medical treatment. If patients are likely to purchase nonprescription medications or supplies, these should be monitored through direct survey as well.

## JOINT PRODUCTION

In some instances, a single product is produced simultaneously with other products. For example, research and education often coincide with the delivery of health care to patients. The accounting profession recognizes several methods for assigning costs to products that are jointly produced (Finkler 1992). The first allocates cost in proportion to each product's physical measure, such as its weight or volume. Another method allocates cost according to the proportion of total sales the two products will yield, less the cost of any processing beyond the point of joint production. These approaches do not apply easily to research and education, however; neither one is physical in nature, nor is research destined for sale.

Incremental cost is often a useful concept for isolating the impact of changes in activities. Incremental cost is the additional cost that results from the production of a good or service, holding the production of all other products constant. Consider an example concerning the nurse time in a clinical research trial (Barnett and Garber 1996). Suppose that patient care activities unrelated to an experimental intervention take up 25 percent of a nurse's time; activities that benefit research and patient care take 50 percent time; and activities needed only for the research protocol take the remaining 25 percent. In this scenario, the incremental cost of research is 25 percent of the nurse's time. Incremental costs must be stated in terms of a given level of production of other products. The extra cost from an intervention adds to total health care costs given current levels of patient care.

The process of studying an intervention may itself change the cost. Patients may need to travel farther to a study site than to their usual health care facilities, for instance. Likewise, time spent by clinicians or managers filling out data collection forms should not be counted as an intervention cost; it is a research production cost.

## THE COMPARATOR

Whenever possible, the cost of an intervention should be measured against a comparator, whether placebo, usual care, or another new treatment. The choice of comparator will guide how costs should be measured. A finer level of detail may be needed when alternative treatments are close substitutes than when they are quite different. For example, a comparison of two surgical techniques for coronary bypass would require time in the surgical suite to be recorded in minutes to accurately capture important differences in the costs of the two procedures. If the comparison were between surgery and pharmacotherapy, however, capturing fine distinctions in surgery time may be unnecessary and a less precise method would probably suffice.

Researchers must scrutinize data collection methods to avoid bias that might favor one treatment arm, given possible incentives for patients or providers. For instance, suppose that a new drug treatment program aims to reduce VA hospitalizations. If it is likely to simultaneously lead to greater use of non-VA services, the cost estimation method should be able to account for both VA and non-VA services with similar levels of accuracy. If the control arm uses more VA care than the experimental arm, then bias could be introduced by relying on more accurate methods for VA services but less accurate methods for non-VA services that tended to underestimate the cost.

## LEVEL OF ANALYSIS

The costs of an intervention may be analyzed at many different levels: the cost per intervention, per clinic visit or hospital stay, per patient contact, per day, and so on. The aggregation level will guide the choice of data collection methods.

The choice of analysis level should be guided by the researcher's ability to collect data with accuracy and precision, and by the cost of data collection. For example, cognitive impairment may prevent patients from completing self-reports accurately (without bias) or precisely (with sufficient detail), but self-reports may be necessary to track at-home care because sending an observer to scores of patient homes could be prohibitively costly and intrusive. Data collection methods are infeasible if potential patients find them intrusive and refuse consent. This suggests focus groups and field tests of primary data collection strategies may be necessary to support cost identification. Examples of such primary collection methods are available for modification to the specific application under scrutiny (Medical Expenditure Panel Survey [MEPS] interviews, National Center for Health Statistics [NCHS] Long-Term Care Survey, VA Cooperative Studies Program (CSP) Non-VA Use Survey, etc.).

## COST DETERMINATION METHOD

### STAFFING COSTS

This section describes common methods of direct measurement of staff costs. These methods include traditional time-and-motion studies, in which someone observes the process of care; activity logs, in which providers monitor their own time; and surveys of managers and patients.

Whatever method is chosen, the local institutional review board (IRB) must approve the data collection method as part of the overall study protocol. The IRB submission will include consent forms and data collection instruments. Data confidentiality and human rights considerations embodied in federal laws such as the Health Insurance Portability and Accountability Act (HIPAA) and the Privacy Act may affect the feasibility of each method.

### TIME-AND-MOTION STUDY

In this approach, the analyst directly observes the staff members and keeps track of the time spent on each activity throughout the day. Observing staff members can yield precise results but is costly because observers must be paid for their time in training and data collection.

It is unnecessary and prohibitively costly to have someone observe clinicians over a very long period of time. An accurate estimate of the average time needed for a procedure or service can be obtained through observations at a sample of times that vary by time of day, day of week, and so forth. If more than one observer will be used, testing should be done to assure interrater reliability. Retraining may be necessary if data collection occurs over a long time period.

It is essential to secure the support of the clinical staff to be observed. At an administrative level, staff permission may be needed to obtain access to clinical areas. And without assurances to the contrary, some clinicians may assume that observational data will be shared with supervisors and form the basis of performance rankings. This is one source of Hawthorne effects, in which clinicians change their behavior when they know they are under observation. Moreover, they should not know the intended hypothesis, as a biased effect will be derived. Observational data must include notes about the exogenous environment, and the potential for confounding effect modifiers (e.g., tension over Joint Commission on Accreditation of Healthcare Organizations [JCAHO] accreditation readiness or the presence of state certifiers in the building).

The timing of time-and-motion studies is another important consideration. Often there are daily, weekly, or monthly patterns in the types of patients seen or procedures performed. The average time spent waiting in a hospital emergency room, for instance, will vary considerably by hour, day of the week, and facility. To obtain the most representative sample of outcomes, ask the clinical staff about changes in case-mix over time. Among the studies using work sampling or comparing results of work sampling to time-and-motion studies are Reid (1975); Brock et al. (1990); Finkler et al. (1993); Guarisco, Oddone, and Simel (1994); and Oddone and Simel (1994).

## ACTIVITY LOGS

A second approach is to have employees keep daily activity logs for a sample of survey dates. The staff members record activities during an interval of work (e.g., 10-, 15-, or 30-minute periods) and characterize whether the activities involve the intervention being studied or some other activity. A prime benefit of activity logs is precision. They are also likely to be more accurate than post-hoc surveys, although they are subject to Hawthorne-type effects because the staff members know they are being monitored. Activity logs carry additional administrative burdens as well: developing and pretesting the survey instrument with allowance for staff members' input, training staff members to use the logs, and following up to ensure that logs are completed and gathered. It may be necessary to survey program managers beforehand to learn which staff members will need to complete logs.

As with direct observation, it may not be necessary to use activity logs for every day of an intervention, particularly if it extends for weeks or months. A random sample of days or hours within a day will suffice, but the sampling frame must be designed with care. If an intervention becomes less intensive over time, for instance, basing an estimate on activity logs from the early days of the intervention would lead to an overestimate of total time spent.

## MANAGER SURVEY

A third method for gathering staff data is to survey managers. The surveys can collect two types of information: the number of full-time-equivalent employees involved in the intervention, and the number of hours spent on the intervention per day or per week. To calculate staff compensation costs accurately, separate responses should be obtained for each category of employee involved: registered nurses, physicians, lab technicians, and so on. Finer detail may be needed if experienced or specially trained providers predominate, as in a neonatal intensive care unit.

Manager surveys are common because they take less time to prepare or complete. A single manager can report on activities of many staff members, and so another advantage is the relatively small number of people who must be surveyed. The primary drawback of manager surveys is a relative lack of accuracy and precision. Managers may have a good sense of the number of days spent on the intervention in a week, for example, but probably will not be accurate at the level of hours or half-hours. The quality of data from manager surveys depends on the effort of the mangers themselves. Manager surveys are not advisable when high precision is needed or when many managers would have to be surveyed to cover the actions of all staff members involved.

## CALCULATING EMPLOYMENT COSTS

Once time spent on an activity has been determined, the next step is to assign a cost to that time. Although hourly or annual earnings may be obtained through surveys, they will not be accurate guides to the total employment cost. Benefits, taxes, and time spent on overhead activities are all parts of the true employment cost, yet employees may have little information on costs incurred by their employer.

It is straightforward to determine hourly employment costs. The first step is to determine annual labor costs, including wages and benefits, assuming a 40-hour work week. To find the raw hourly cost, divide the annual cost by 2,088, the number of hours in a 52-week work year. The raw figure includes time spent on activities other than patient care such as vacation, sick leave, and administrative work. Because such nonapplied time must be spent in support of carrying out an intervention, it is necessary to adjust the hourly cost to reflect this extra cost.[1]

There are two sources of VA employment costs. The first is the VA payroll system, known by the acronym PAID. Access to PAID is limited to VA employees who can substantiate a need for employee-level detail. The second source is the Financial Management System (FMS), also known as the VA general ledger. FMS data are available to employees who have access to the VA's Austin Automation Center. FMS reports all labor costs, including benefits and employer contributions to taxes. The data are arranged into subaccounts, of which 72 correspond to occupation classifications. Data are reported separately for each VA facility, allowing calculation of local as well as national average costs. A guide to using FMS to determine employment costs is available from the authors.

Check the employment costs source before designing data collection instruments. It will greatly ease the process of assigning costs if the data collection forms use the same occupation categories as the cost data. One difficulty

faced by VA researchers is the small number of FMS subaccounts for administrative work. If more specificity is needed than FMS can provide, one can collect employment cost data through surveys of employees or their managers.

## SUPPLY, EQUIPMENT, AND CAPITAL COSTS

The costs of supplies and equipment may be gathered through manager surveys or by contacting manufacturers. Two caveats are in order. First, supply and equipment costs may fall if a new intervention is widely adopted. Both competition and economies of scale in production can lead the price of goods to fall as the number of items produced rises. Second, the list price of a good may greatly overstate the cost of supplies and equipment because large providers like VA frequently negotiate substantial discounts. The average wholesale price of pharmaceuticals, for instance, is often substantially higher than negotiated rates available to VA (Smith and Joseph 2003).

There are several data sources for VA capital costs. The first is the VA Cost Distribution Report (CDR), which provides the depreciation on VA buildings and equipment, but omits the cost of financing (Barnett 1999). Like FMS, the CDR may be accessed by VA employees with access to the Austin Automation Center.

Although from an accounting viewpoint VA buildings are completely depreciated after 30 years, they still have economic value. The value of the next-best alternative use can be determined by the cost of renting similar facilities or by the replacement cost of the VA facilities used in the study. Estimates of land values and rental rates for medical office space may be obtained from real estate agents or other local sources.

The replacement cost of current VA facilities may be estimated through a combination of VA financial data and proprietary commercial data (Rosenheck, Frisman, and Neale 1994). They suggest two alternative methods, one based on rental rates for similar properties and another based on replacement costs. Unfortunately, these methods can lead to very different conclusions. Across nine VA facilities, Rosenheck and colleagues found the capital cost based on rental rates to be nearly 40 percent lower than costs based on replacement. There are no a priori grounds for preferring one method to the other.

## OTHER COSTS

Other types of costs that need to be measured include the cost of care provided in other health care systems, out-of-pocket costs incurred by patients, including the travel cost and nonprescription medications, and the value of

patients and informal caregivers' time. This section describes methods for estimating each of these.

Estimates of these costs are often based on surveys. Patients are asked about medication use, care received from other physicians and hospitals, the cost of travel to providers, and time spent seeking health care. The validity and reliability of such survey instruments have not been extensively studied. Length of accurate recall is an important issue that is frequently ignored. Recent research on factors affecting recall include Simmons and Schnelle (2001), Clegg et al. (2001), and Nicholson et al. (2000). Methods for reducing errors include asking patients to keep daily or weekly logs, bring in prescription bottles or papers, and provide bills from inpatient visits. Proxies may be necessary for patients who have cognitive or physical impairment, introducing another source of possible bias.

## NON-VA CARE

Patients may obtain health care beyond the institution where an intervention occurs. In theory, it could account for a substantial proportion of health care spending. As noted earlier, inpatient cost and utilization is best captured by asking patients to submit logs of outside care and then writing to providers for details. If patient surveys are not feasible or do not produce adequate information, other sources may be consulted. These include VA administrative files (for VA-funded care at non-VA facilities), Medicare files, and national surveys.

VA researchers may turn to administrative sources that report payments to non-VA providers for care given to veterans. The Fee Basis files contain the cost of inpatient and outpatient services provided to VA patients by contract providers, and by noncontract providers who gave care on an emergent basis. The quality and completeness of the Fee Basis data have not been determined, however. The VA discharge files, known as the Patient Treatment Files (PTF), include non-VA inpatient stays provided under contract to VA. The PTF reports discharge date, length of stay, and Diagnosis Related Group, but not the cost of these stays.

Medicare is a prominent source of non-VA care for veterans. For a fee, researchers can request Medicare utilization and cost data from the Center for Medicare & Medicaid Services (CMS). VIREC is engaged in a project to merge Medicare data with standard VA utilization data (Hynes, Cowper, and Stefos 1999).

There are other sources of person-level cost data, although they will not be linkable to VA patients. These include national surveys such as MEPS, the

Healthcare Cost and Utilization Project (HCUP), and the Medicare Provider Analysis Review (MEDPAR), surveys carried out by professional societies, and private firms that manage health care claims.

Two articles in this supplement illustrate how costs may be estimated through a combination of internal and external data sources. Wagner, Chen, and Barnett (2002) used MEDPAR and VA information to estimate costs of VA medical-surgical inpatient stays. Phibbs et al. (2003) estimated VA ambulatory care costs using Medicare payment scales (Resource-Based Relative Value scale [RBRVS]) and others. The studies conclude that combining utilization and cost data from separate sources requires particular care. Costs in one source may refer to utilization categories that do not match those in other sources. Arbitrary simplifications are often necessary.

## TRAVEL AND TIME

Analyses from a societal viewpoint include patient travel cost. Patients may be surveyed about the specific mode of conveyance and the number of miles traveled. This adds considerable complexity and may not be worthwhile if patient-incurred travel costs are a small fraction of total costs. An alternative approach is to calculate the straight-line distance from the patient's residence to the health care provider and then apply a standard mileage rate, such as the amount allowed by the U.S. Internal Revenue Service for business expenses. Without much loss of accuracy, this may be further simplified by estimating travel cost using the distance between the geographic center of the postal zip code of the patient's residence and that of the provider's location (Phibbs and Luft 1995).

Beyond the direct cost of travel is the implicit value of time spent traveling. Patients also spend time obtaining care. Society values this time, and so it must be assigned a cost in an analysis from a societal viewpoint. Analyses from the viewpoint of a payer such as VA or Medicare would not include patient time.

There are several approaches to valuing patients' time. For employed persons, the hourly wage is a reasonable measure of time cost. Many veterans and their caregivers are retired, however, and so a current wage will be unavailable. A standard practice is to assign either the minimum wage or the national average wage for home health care workers, the latter available from the U.S. Department of Labor or in the Statistical Abstract of the United States (U.S. Census Bureau 2002). An alternative to valuing time directly is to factor it into the change in quality-adjusted life years due to an intervention; Garber et al. (1996) provide an overview of this concept and recommendations.

## DATA QUALITY

Ensuring data quality is as important as choosing a good method for collection. This section briefly discusses precision, accuracy, and reliability, each of which directly affects data quality.

The level of precision needed in data collection will depend on the intervention. Consider an intervention that takes 15 minutes to perform. In an outpatient setting, it may be sufficient to use a survey that records time in 15-minute intervals. The overhead cost of surgery suites is typically billed by the minute, however, and so for surgical interventions the instrument would need to record time at the minute level. Billing methods are thus a second guide when designing survey instruments.

Accuracy in gathering data is an important consideration because even small errors in reporting can accumulate from repetition. A rounding error of 1 to 2 minutes per event may become large when separate measurements are accumulated. Solutions include improved training of survey staff and pilot testing and revising data collection instruments. In some cases it may be necessary to change the basic method of data collection. If pilot testing reveals that nurses feel too busy to keep accurate time logs, for instance, direct observation by a third party could be used instead. Motivation, training, and clinician input into the observation method can all improve accuracy.

When data are collected through direct observation, the accuracy of the data will rely on the people collecting it. There are several steps that can be taken to increase reliability. Data collectors must be trained to ensure that they understand the collection forms. Retraining is advisable during lengthy collection periods. The degree of consistency between collectors—known as interrater reliability—is an important measure (Dunn 1992; Kelsey et al. 1996). It can be assessed by comparing the results when two or more people collect data from the same source.

In a famous study of General Electric's Hawthorne plant, researchers determined that employees were becoming more productive not from repeated changes in the work environment but from the knowledge that they were being carefully watched (Franke and Kaul 1978). The same issue can arise in clinical studies. Patients under study may be more likely to take medications; clinicians may work more slowly to avoid accidents or, conversely, they may work more quickly to appear more efficient. Regardless of the direction of effect, Hawthorne effects will bias study results because they will not appear under normal circumstances if the intervention is adopted widely. Researchers collecting data by direct observation can reduce the probability of Hawthorne effects by making the observation process as unobtrusive as possible. For example, recording an intervention on film and later assessing the

time spent would be less intrusive than standing at bedside with a stopwatch and a clipboard.

## SUMMARY

A plan for collecting data on each cost element should be determined during the planning phase of a study. Clinical input will be essential in choosing a method and setting a timetable for collection. Here we summarize the major elements that enter into the choice of direct measurement method.

Beyond the choice of intervention and any comparators, the range of costs to be measured will rest largely on the study perspective. The standard for cost-effectiveness analyses is the societal viewpoint, although others may be useful for comparison. The process of care must be understood to distinguish the intervention itself from actions taken only to study the intervention. Costs such as royalties and capital expenses that count in a long-run timeframe may not be applicable to short-run analyses.

There are three basic methods of direct observation: time-and-motion studies, activity logs, and surveys of patients, providers, and managers. The most appropriate one will depend on clinical input, the location of intervention activities (e.g., at-home vs. in-hospital), and the presence or absence of appropriate administrative data. Administrative data will most likely be needed to estimate any long-term capital costs arising from the intervention. If costs for supplies and equipment are not available from administrative data, it will be necessary to measure them directly through surveys or direct contact with suppliers and manufacturers. Patient-incurred costs for over-the-counter supplies and medications, time spent obtaining care, and travel will require patient surveys.

Because surveys play an essential role in direct measurement, proper survey design is essential. Recent books on survey methodology include Fowler (1995), Converse and Presser (1996), Aday (1996), Rea and Parker (1997), and Dillman (2000). Published studies can offer guidance based on clinical experience. Some studies compare the reliability and validity of competing approaches, such as self-reports versus administrative data extracts (Korthuis et al. 2002) or self-reports versus proxy reports (Grootendorst, Feeny, and Furlong 1997). There is a vast literature describing the design and testing of survey instruments for particular subgroups; see, for instance, Field et al. (2002), Kahn et al. (2002), and Kressin et al. (2002). The VA Measurement Excellence Initiative has developed detailed reviews of the properties of many survey instruments. The reviews appear on its Web site (www.measurementexperts.org). A third source of design advice are research teams who have done similar studies. They may have knowledge to share on the success of particular

survey instruments in their own research. One can also obtain input on survey design from those who will complete them. Pilot testing can reveal confusing questions, poor graphic design, and other problems.

The data collection method must be feasible and feature clinical, financial, and temporal dimensions. It must not interfere with the giving of care. It must be able to distinguish costs of intervention and comparator. And it must be possible to accomplish within an acceptable timeframe and within financial means. Although using electronic sources of administrative data can save considerable time and energy, the accuracy of administrative data can vary considerably by source, across facilities, and over time. Validation studies are useful guides for determining which sources are reliable.

It is often advisable to use two or more methods in the same study to save money while obtaining an acceptable level of precision and accuracy. Consider a study comparing surgical and drug treatment. An analyst might use staff surveys or study logs to determine the cost of the initial treatment. A less precise but less costly method such as average costing could be employed to determine the cost of subsequent health care (Swindle et al. 1999). The tradeoff is between precision and implementation cost: more precise methods are typically the most labor intensive and hence the most costly to carry out.

In general, one can use direct measurement for elements most important to the study outcome and average costing for elements that are less central. It is often sensible to use average-cost methods for inpatient care when the treatments being studied are unlikely to have an impact on inpatient utilization. Wagner et al. (2002) and Phibbs et al. (2003) describe average-cost data sets created for the VA system.

## AREAS FOR FUTURE RESEARCH

Every kind of direct measurement requires a data collection instrument. Survey design issues are rarely acknowledged in cost-effectiveness research, a needless omission considering that fundamental characteristics like validity and reliability are straightforward to test. From the VA perspective, psychometric testing in an elderly population would be of great value. More research is also needed into the accuracy of self-reported costs, such as over-the-counter and travel costs.

A second design issue, the ability of patients and providers to recall events, appears to get even less attention but may greatly impact the accuracy of survey measurement. A fruitful area for future research would be the development of standardized questions for the gathering of cost and utilization data. The field of cost-effectiveness research would benefit greatly if surveys of this

kind were given the kind of careful attention paid to psychometrics and quality of life.

## NOTE

1. Suppose that 90 percent of an employee's time is applied to patient care and other intervention-related activities, and 10 percent to overhead. Multiply the raw hourly cost by (1.00/0.90), or 1.11. If 15 percent of the employee's time were spent on overhead activities, the adjustment would be (1.00/0.85), or 1.18.

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# Pharmacy Data in the VA Health Care System

*Mark W. Smith*
VA HSR&D Health Economics Resource Center,
VA Palo Alto Health Care System;
Center for Primary Care and Outcomes Research,
Stanford University
*George J. Joseph*
VA Information Resource Center, Spinal Cord
Injury Quality Enhancement Research Initiative,
and Midwest Center for Health Service and
Policy Research, Edward Hines Jr. VA Hospital

*Recent advances in Department of Veterans Affairs (VA) health care data systems have greatly increased access to operational pharmacy information. This article presents a brief guide to VA pharmacy data sources: the Veterans Health Information Systems and Technology Architecture files, the Pharmacy Benefits Management database, Decision Support System (DSS) National Data Extracts for inpatient and outpatient care, the planned DSS National Pharmacy Extract, DSS databases at local VA facilities, and the Non-VA Fee Basis files. Depending on the source, available data elements include patient demographics, clinical care information, characteristics of the medication and of the prescribing physician, and cost. Access policies are detailed for VA and non-VA researchers. Linking these sources to VA databases containing data on inpatient and outpatient services offers a comprehensive view of health care within several VA populations of general interest, including people over age 65 and those with physical and psychiatric disabilities.*

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Continuing advances in health data systems within the Department of Veterans Affairs (VA) offer a new opportunity to study health care use among adults. VA databases of inpatient and outpatient health care utilization have existed for many years, and their utility for research has been documented elsewhere (Murphy et al. 2002). Only recently, however, has it been possible to link pharmacy data to VA patient-level utilization data. This article presents a brief guide to four sources of VA pharmacy data stored in electronic formats. It describes the contents and use of the data sources, noting strengths and limitations of each for research. We discuss access policies and offer guidance on selecting data sources based on the research questions proposed.

The VA patient population is of considerable interest due to its large size and nationwide representation. Vulnerable populations, such as people with low incomes, disabilities, or mental health and substance abuse problems, are present in substantial numbers. Although many VA patients are elderly men, the numbers of younger veterans and women allow for analysis of these groups as well.

The data sources we describe represent an important resource for health services research. Rising health spending is often linked to steady increases in the use of outpatient prescription drugs. There are several large non-VA prescription databases with information on privately insured individuals, but they have relatively few people over age 65. That population is growing, however, and its use of prescription medications is rising briskly (Parks Thomas, Ritter, and Wallack 2001). VA data are an important resource for understanding patterns and costs of pharmacy use by a large, predominantly elderly population.

Cost-effectiveness studies and related research are often performed using VA pharmacy data, but the advent of improved pharmacy data systems in recent years has opened up additional avenues of research. Risk-adjustment mechanisms based entirely on pharmacy claims have been developed for several populations (Gilmer et al. 2001; Lamers 1999; Fishman and Shay 1999; Fishman et al. 2003). Pharmacy data have been used to assess adherence to clinical practice guidelines by providers (Pillans et al. 2000; Fortney et al. 2001) and by patients (Melfi et al. 1998; Hoffman et al. 2003). They also represent an

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important means by which to measure the impact of uninsured status on health care (Schoen et al. 2001; Smith et al. 2001). All of these issues, and many others, can be addressed using VA pharmacy data, either alone or in combination with other sources.

We will begin with the pharmacy ordering process, describing its data elements and the interaction of provider and pharmacist. We then describe the larger clinical data system surrounding the pharmacy order process. Although that system can be accessed directly, most researchers instead draw pharmacy data from secondary sources. The remainder of the article describes three of these and notes additional minor sources. We provide side-by-side comparisons of the structure and contents of the major data sources in table format.

## NEW CONTRIBUTION

To our knowledge, this is the first published resource describing the contents of multiple VA pharmacy data sources, which are unknown to many researchers. VA pharmacy databases are comprehensive, recording all aspects of prescription drug therapy across inpatient and outpatient settings. Medical supplies and other related products dispensed by VA pharmacies are included. VA costing methods allow for a comprehensive review of direct and indirect costs. A unique feature of the VA system is the existence of several pharmacy data sources, enabling researchers to view the data from a number of administrative and health services perspectives.

## PRESCRIPTION ORDERING

VA stores patient medical records in electronic format. The records are accessed through the Computerized Patient Record Systems (CPRS). CPRS is one component of the larger clinical and management information system known as the Veterans Health Information Systems and Technology Architecture (VISTA). Providers use CPRS to review and update patient medical records and to place orders for medications, procedures, and tests (Veterans Health Administration 2003). Many data files and applications within VISTA support CPRS and its graphical user interface (CPRS-GUI).

Providers with authorization to make orders are given access to the CPRS pharmacy order screen. In the outpatient setting, after logging into CPRS-GUI, the provider selects the Add Orders Menu to order lab tests, radiological tests, medications, medical supplies, and other items. If the outpatient medication menu is selected, the medication order box appears. The provider

selects a pharmacy orderable item from the alphabetical list of generic and branded products (e.g., METOPROLOL TARTRATE TAB) in the medication order box. When a particular item is selected, the order dialog screen appears. It lists the available dosages (e.g., 12.5 mg, 25 mg, 50 mg, 100 mg, and 200 mg). The price per dispensed unit corresponding to each dosage will appear along with the associated route of administration, or method of consumption. Routes of administration include intravenous (IV), oral (PO/ORAL), and many others. Only the route that applies to a specific dosage form will appear when the product is selected. If a tablet is chosen, for example, only PO/ORAL will appear. After choosing the dosage and route, the provider specifies the schedule of administration. The schedule is the frequency of consumption, such as twice per day (BID) or three times per day (TID). The provider can also enter additional instructions for the pharmacist or patient in a free-text field. These comments appear with the dosing instructions.

Depending on the product selected, the CPRS-GUI may flash messages associated with the product. The messages may suggest specific days supplied, provide information about product restrictions, or give information regarding policy or pricing. A message about days supplied might encourage the provider to choose particular values. If there is no such message, then he or she must specify the number of days supplied and the number of refills deemed appropriate. VA pharmacies customarily fill either 30- or 90-day supplies of routine medications. The total quantity dispensed (e.g., tablets, vials) is automatically calculated by VISTA based on the dosage, schedule, and days supplied selected, although it may be altered manually by the provider. The provider then specifies the pickup method of the prescription; options include mail-order, the medical center pharmacy, and in-clinic (e.g., for vaccinations). Finally, the priority of the prescription is specified as routine, urgent, or immediate.

The dosing instructions field is automatically generated based on product information in VISTA files and order elements selected by the provider. The order software calculates the quantity to be consumed at each dose based on the chosen values of strength, dosage, and schedule. It then attaches any free-text comment the provider has made. The result is a statement in plain English. For example, an order for METOPROLOL TARTRATE tabs, 50 mg strength, PO/ORAL route, with BID schedule and a free-text instruction to consume the drug after meals would yield the following instructions: "METOPROLOL TARTRATE TAB 50 MG. TAKE ONE TABLET BY MOUTH TWICE A DAY AFTER MEALS."

The final steps involve verification by the provider and pharmacist. After reviewing the order elements, the provider clicks the "accept" button. This

causes the order to appear in the patient's list of medications, a different tab within the CPRS-GUI. The provider then electronically signs the order. The order appears in VISTA File 52.41, the Pending Prescriptions Menu. A pharmacist finishes the order by checking it for consistency. Prescriptions destined for mail-order delivery are dispatched to one of seven VA Consolidated Mail Outpatient Pharmacies (CMOPs). Otherwise the prescription is filled, labeled, and dispensed via the facility's pharmacy.

VA pharmacists are not required to follow every aspect of prescription orders. Within limits, a pharmacist may change the strength and quantity supplied of a medication. For example, an order for 150 tablets at 50 mg strength might be filled as 75 tablets at 100 mg strength. The pharmacist would then alter the dosing instructions as well to indicate splitting the scored tablet using a splitting device provided by the pharmacy.

The prescribing sequence for inpatient care is slightly different and depends on whether the order is intravenous (IV) or unit dose (UD). For an IV order, the provider can specify the solution (active or inert), the additive (medication), infusion rate, and priority. For a UD order, the provider specifies the dosage, route, schedule, comment, and priority. There is also a checkbox to indicate that an additional dose is to be given immediately upon receiving the order, rather than waiting until the next regularly scheduled time as indicated on the order form.

The CPRS-GUI is a dynamic system. Providers have access to a Quick Orders Tabs for inpatient and outpatient medications. They feature commonly used combinations of strengths, routes of administration, quantities supplied, and refills for the most common VA drug classes and other selected medications. If a provider chooses any of these combinations, the order dialog screen is automatically populated with most information required for the order; the provider need only specify changes such as pickup method (for outpatient prescriptions) and priority, and then accept and sign the order.

## MAJOR PHARMACY DATA SOURCES

This section provides an overview of four VA electronic sources of pharmacy data. The first is VISTA, the integrated system of software and hardware of which the ordering system described above is one part. The three other sources obtain much of their data from VISTA. They include the Pharmacy Benefits Management (PBM) Version 3.0 database, the Decision Support System (DSS) National Data Extracts for inpatient and outpatient care, and the planned DSS National Pharmacy Extract.

## VISTA

Much of the information in all electronic pharmacy datasets originates as data captured in VISTA. VISTA is the VA hospital information system, comprising a variety of software and integrated data systems written in Massachusetts General Hospital Utility Multi-Programming System (MUMPS® or "M") (Hynes, Joseph, and Pfeil 2002).[1] VISTA consists of computer systems at each VA medical center and the national network that links them (Veterans Health Administration 2003). The nationally distributed VISTA software includes numerous "modules," "applications," and "packages" designed to store data on a particular subject and to produce management reports.

## VISTA Pharmacy Data Files

The VISTA pharmacy package comprises 13 applications that gather, process, and store data pertaining to prescriptions and orders written and filled within the VA system (Veterans Health Administration 2003). Completed pharmacy transactions are stored in two locations in VISTA: the Prescription File (FILE 52) for outpatient prescriptions and the Pharmacy Patient File (FILE 55). FILE 55 has two subfiles, one for IV orders (FILE 55.01) and one for Unit Dose orders (FILE 55.06). Information specific to a particular prescription, such as start date and quantity dispensed, is stored in one of these files depending on the type of prescription.

In the prescription process, VISTA draws information from several files. The VA Product Name, National Drug Code (NDC), and price per dispensed unit come from the VISTA Local Drug File (FILE 50). Information regarding the provider is attached from the New Person File (FILE 200). As a result, each completed pharmacy transaction record contains significantly more information than what the physician entered via CPRS when ordering a prescription.

As discussed by Hynes, Joseph, and Pfeil (2002), VISTA is a patient care system, and data generally must be exported from VISTA to another environment to enable research use. Because VISTA was developed using M (formerly MUMPS), programs written using M software are the primary means to create extracts from VISTA packages. This can be a labor-intensive process involving development and validation of computer programs and the resulting data extract. Due to differences in VISTA implementations across sites, it may be necessary to modify a program for use at multiple sites.

Most VA researchers instead make use of derived data sources that draw from VISTA. For pharmacy data, two key sources are the Pharmacy Benefits Management (PBM) database and the National Data Extracts (NDEs) for inpatient and outpatient care produced from the VA Decision Support System

(DSS). When available, the planned DSS National Pharmacy Extract will be another important source. The DSS National Pharmacy Extract and PBM database extract information from VISTA and keep it at the level of individual prescriptions. The DSS NDEs for inpatient and outpatient care extract VISTA data and roll it up to the level of encounters. Each of the sources adds additional fields not found in VISTA.

## PHARMACY BENEFITS MANAGEMENT (PBM) DATABASE

The Pharmacy Benefits Management Strategic Healthcare Group (PBM/SHG) is a VA entity responsible for managing the national VA drug formulary process. It carries out a broad range of activities related to pharmacy purchasing, clinical guidelines, and outcomes research (Ogden et al. 1997). To facilitate its work, PBM/SHG has developed software systems and databases to organize and analyze drug data. PBM data files are created and stored by the PBM/SHG at the Edward Hines Jr. VA Hospital in Hines, IL.

Every month, 128 VISTA systems representing every VA facility run the PBM V3.0 software to create a specialized data extract. The individual extracts are transmitted to PBM/SHG, which combines them, cleans and validates the data, creates additional elements, and stores them in an Microsoft® SQL® database. These data are made available to researchers as a flat file in Microsoft Visual FoxPro®, Microsoft Access®, or SAS® format.[2] The PBM database covers all pharmacy transactions (medications and supplies) from October 1, 1998, until about 60 days prior to a given date. The database is at the level of individual prescriptions, and thus a person can have multiple records on a given day. Although both inpatient and outpatient data are extracted, only the outpatient PBM data files are currently viable for research. This article, therefore, focuses on the outpatient data in the PBM database.

## DSS NATIONAL DATA EXTRACTS FOR INPATIENT AND OUTPATIENT CARE

DSS is an automated management information system that tracks health care workload (i.e., utilization) and assigns an approximate cost to it. Each VA facility has a separate implementation of DSS, referred to as a DSS production database. The DSS production databases are standardized in structure and calculate the same cost and utilization figures. Although there is some variation across sites in the way costs are assigned to procedures (e.g., cardiac catheterization), pharmacy data appear to be treated uniformly. DSS NDEs for inpatient and outpatient care are SAS datasets created from the DSS production databases, as will be the planned DSS National Pharmacy Extract.

The DSS NDEs for inpatient and outpatient care contain summary utilization and costs data at the level of inpatient stay or outpatient health care encounter. The DSS inpatient data reside in two datasets: the DSS Discharge NDE, with data organized by inpatient stay (from admission to discharge), and the DSS Treating Specialty NDE, with data organized by inpatient provider specialty. There may be multiple records pertaining to a single inpatient stay in the Treating Specialty NDE. In the Outpatient NDE, a record represents a single interaction between a provider and a patient in an outpatient setting. Roughly one-third of DSS outpatient encounters represent a patient picking up a prescription at a VA pharmacy or a VA mail-order pharmacy filling and shipping an order. A person may have multiple records in the DSS Outpatient NDE dataset for a single day, though this is less likely than in the prescription-level PBM database.

DSS assigns both direct and indirect costs to inpatient and outpatient services, including pharmacy services. One element of the direct cost of a pharmacy service is VA's purchase price for the medication dispensed. Other direct and indirect (overhead) costs are assigned based on workload of the pharmacy department and costs assigned to the department in the VA general ledger. In the encounter-level inpatient and outpatient NDEs, it is not possible to attribute costs to specific inpatient prescriptions or other pharmacy services.

### DSS NATIONAL PHARMACY EXTRACT

A third NDE pertaining to pharmacy data is in development. To avoid confusion with the main inpatient and outpatient NDEs, we will refer to it as the DSS National Pharmacy Extract. Each record will represent a single pharmacy product (prescription, supply, or other), and so there may be multiple records for a patient on a given day. A limited set of clinical and cost variables will be available as well, as detailed below.

## ACCESS REQUIREMENTS

Access to VISTA systems is granted by the Information Resource Management (IRM) office at each facility. Separate institutional review board (IRB) approval for research use of the data is necessary at each facility as well.

For PBM data, researchers have access only to special-use data extracts created by the PBM/SHG field office at Hines VA Hospital. Requests for PBM data are fulfilled if the PBM/SHG confirms the following: the proposed data use will not conflict with PBM/SHG's primary mission of managing the VA formulary process; IRB approval has been granted; all applicable laws, regulations, and VA policies are being followed, including those pertaining to data

confidentiality and human rights; and the requestors have completed a use and nondisclosure agreement.[3] Non-VA researchers are provided PBM data by the PBM/SHG only if they are collaborating with a VA employee or belong to an official oversight body.

PBM/SHG will not release data for research if the design appears to favor a particular medication or class of medications or if the study is not scientifically valid. An example of a study for which the data request was rejected is a comparison of a branded drug to placebo without comparison also to a second standard medication for the same condition. Another example of a study denied PBM data is a project designed from a commercial perspective to measure the market share of a branded drug within the VA system.[4]

In some cases, there will be a charge for PBM data. VA employees may access the data for management purposes at no charge. Often there is no charge to create an extract for pilot VA research projects. For funded research, the PBM/SHG staff will request payment in proportion to the staff time needed to consult on protocol design and to compile, analyze, and report the data. In the case of simple data extracts that do not require protocol design assistance, there is only a nominal charge to cover programmer time.

The DSS NDEs for inpatient and outpatient care are stored in Austin, TX, at the VA Austin Automation Center. Access requires a timeshare account and specific dataset authorization from the VA Automated Customer Registration System (ACRS). An ACRS Point of Contact at the local facility handles most requests. This person often is the facility's Information Security Officer. Authorization also requires completion of a DSS data nondisclosure agreement. Non-VA users must obtain additional approvals. See the VIReC Web site for additional information and assistance.[5] Access to the planned DSS National Pharmacy Extract is expected to be similar.

Although the DSS production databases contain real social security numbers (SSNs), the DSS NDE inpatient and outpatient datasets feature only a scrambled SSN. Researchers requesting authorization to use the DSS NDE datasets can specify access to files with real or scrambled SSNs. A signed Privacy Act statement will be required from researchers requesting DSS NDE datasets with real SSNs.

Table 1 summarizes characteristics of the three VA pharmacy data sources with respect to structure, coverage, and access.

## DATA ELEMENTS

In this section, we focus on selected data elements and which VA pharmacy data sources include them. Table 2 shows selected data elements of VISTA, the PBM database, and the DSS datasets arranged in categories corresponding to

*(text continues on p. 106S)*

TABLE 1 Structure and Access of Four VA Pharmacy Data Sources

| | | *PBM Outpatient Database* | *DSS National Pharmacy Extract (planned)* | *DSS In/Outpatient National Data Extracts* | *VISTA* |
|---|---|---|---|---|---|
| Structure and Coverage | Record level | prescription | prescription | encounter | prescription |
| | Data format | several[a] | SAS® dataset | SAS® dataset | raw text |
| | Coverage | all sites | all sites | all sites | one site[b] |
| | Multiple prescriptions in one record | | | ✓[c] | |
| | Includes outpatient prescriptions | ✓ | ✓ | ✓ | ✓ |
| | Includes inpatient prescriptions | | | ✓ | ✓ |
| Access | Location[d] | PBM/SHG | AAC | AAC | IRM |
| | Method of access | request | SAS® program | SAS® program | M program |
| | Separate IRB approval for each site | | | | ✓ |
| | Separate IRM approval for each site | | | | ✓ |
| | Protocol approval required | ✓ | | | |
| | Fee-based consulting available | ✓ | | | |

a. Options include SAS® and Microsoft Access® or Visual FoxPro®.
b. A Veterans Health Information Systems and Technology Architecture (VISTA) extract pertains only to the VA medical center (VAMC) that created it. There may be several VA facilities within a single VAMC.
c. The Decision Support System National Data Extract (DSS NDE) record reflects all pharmacy activity during an encounter, which could include multiple prescriptions.
d. PBM/SHG = Pharmacy Benefits Management Strategic Healthcare Group (Hines, IL); AAC = VA Austin Automation Center, accessed through a time-share account; IRM = the VA Institution Resources Management office at each VA medical center.

TABLE 2 Data Elements of the PBM Database, Planned DSS National Pharmacy Extract, Inpatient/Outpatient DSS National Data Extracts, and VISTA

| | *Variable Description* | *PBM Outpatient Database* | *DSS National Pharmacy Extract (planned)* | *DSS In/Outpatient National Data Extracts* | *VISTA* |
|---|---|---|---|---|---|
| Medication | National Drug Code (NDC) | ✓ | ✓ | | ✓ |
| | Station product name or description | ✓ | | | ✓ |
| | VA product name | ✓ | ✓ | | ✓ |
| | VA drug class | ✓ | | | ✓ |
| | Regional (VISN) formulary indicator [a] | ✓ | | | ✓ |
| | National formulary indicator | | | | ✓ |
| | National formulary restrictions | ✓ | | | ✓ |
| Dispensing Details | Fill date | ✓ | ✓ | ✓ | ✓ |
| | Prescription number | ✓ | | | ✓ |
| | Total quantity dispensed | ✓ | ✓ | | ✓ |
| | Dispensing unit (mg, ml, etc.) | ✓ | | | ✓ |
| | Dosing instructions | ✓ | | | ✓ |
| | Days supplied | ✓ | —[b] | | ✓ |
| | New fill/refill/partial indicator | ✓ | —[b] | | ✓ |
| | Mail or window pickup indicator | ✓ | —[b] | | ✓ |
| | Medication counseling acceptance indicator | ✓ | | | ✓ |
| Cost | Purchase price (from cost schedule) | ✓ | | | ✓ |
| | Purchase price per dispensed unit | ✓ | | | ✓ |

| | | | | | |
|---|---|---|---|---|---|
| | DSS fixed direct cost | | | ✓[c] | |
| | DSS variable direct cost | | | ✓[c] | |
| | DSS indirect cost | | | ✓[c] | |
| | DSS total cost | | ✓ | ✓[c] | |
| | DSS average dispensing cost | | ✓ | | |
| | DSS variable supply cost | | | ✓[c] | |
| Clinical Data—Outpatient | Clinic code | —[d] | ✓ | ✓ | ✓ |
| | DSS department number | | ✓ | ✓ | |
| | Diagnosis codes | | —[e] | —[e] | ✓ |
| | Procedure codes (CPT) | —[d] | | —[e] | ✓ |
| | Laboratory & radiology tests | | —[f] | —[f] | ✓ |
| Clinical Data—Inpatient | Admission date | | ✓ | ✓ | ✓ |
| | Discharge date | | ✓ | ✓ | ✓ |
| | Treating specialty | | ✓ | ✓ | ✓ |
| | Bedsection (ward) | | ✓ | ✓ | ✓ |
| | Diagnosis codes | | ✓[e] | ✓[f] | ✓ |
| | Admitting DRG | | | ✓ | ✓ |
| | Discharge DRG | | | ✓ | ✓ |
| | Procedure codes (CPT) | | | | ✓ |
| | Laboratory and radiology tests | | | —[g] | ✓ |
| Patient Demographics | True social security number (SSN) | ✓ | ✓ | ✓ | ✓ |
| | Scrambled SSN | | | ✓ | |
| | Date of birth | | ✓ | ✓ | ✓ |
| | Age | | | ✓ | ✓ |
| | Gender | | ✓ | ✓ | ✓ |
| | Low-income identifier (means test)[h] | | ✓ | | ✓ |

*(continued)*

TABLE 2 (continued)

| | *Variable Description* | *PBM Outpatient Database* | *DSS National Pharmacy Extract (planned)* | *DSS In/Outpatient National Data Extracts* | *VISTA* |
|---|---|---|---|---|---|
| | Zip code | | ✓ | | ✓ |
| Physician/ Provider | Provider ID[i] | ✓ | ✓ | ✓ | ✓ |
| | Provider type | ✓ | | ✓ | ✓ |
| | Provider class | ✓ | | | ✓ |
| | Provider service/section | ✓ | | | ✓ |
| | Provider specialty and subspecialty | ✓ | | | ✓ |
| | Primary care team | | ✓ | | ✓ |
| | Primary care provider ID | | ✓ | ✓ | ✓ |
| | Primary care provider type | | | ✓ | ✓ |
| | Associate primary care provider ID | | ✓ | ✓ | ✓ |
| | Associate primary care provider type | | | ✓ | ✓ |
| Pharmacy | Station number (facility ID) | ✓ | ✓ | ✓ | ✓ |
| | VA regional network (VISN) | | | ✓ | ✓ |
| | Consolidated Mail Outpatient Pharmacy (CMOP) indicator | ✓ | ✓ | | ✓ |

a. VISN = Veterans Integrated Service Network, a regional network of VA facilities.
b. Planned fields not yet available.
c. Reflects all pharmacy transactions during an encounter.
d. Pharmacy Benefits Management (PBM) data could be matched to the standard outpatient utilization file, but a particular prescription could not be attributed to a particular clinic stop, procedure, or diagnosis, if more than one appeared on the outpatient record for that day.
e. Primary diagnosis or procedure only. Others available by linking to standard VA utilization files.

f. Separate Decision Support System (DSS) extracts record laboratory and radiology/nuclear medicine tests. An extract containing laboratory test results is under preparation.
g. Treating specialty diagnosis code for the bedsection segment during which the pharmacy order occurred.
h. The cost of some VA services will depend on the patient's service connection (0%-100% or none) and household income.
i. The provider ID is the provider's SSN in the PBM data, and the NPCD provider ID in the DSS NDE and Pharmacy Extract. The NPCD provider ID allows the provider to be tracked in the standard VA health care utilization files.

characteristics of the medication, dispensing details, cost, clinical data, characteristics of the patient and the provider, and the pharmacy. VISTA contains a very large number of data elements, including several pharmacy-related management modules. We will show only those VISTA elements that appear in the PBM or DSS pharmacy databases. A listing and brief description of VISTA modules appears in the VISTA Monograph (Veterans Health Administration 2003).

## MEDICATION AND DISPENSING DETAILS

The PBM database contains the most information on the prescribed medication. Variables include the National Drug Code (NDC), locally assigned drug name (station product name), uniform drug name (VA product name),[6] national formulary indicator, VISN (Veterans Integrated Service Network) formulary indicator, and other indicators not shown in Table 2. Two formulary indicators appear because VA medical centers may have medications on their formularies that do not appear on the national VA formulary. The DSS NDEs have no information on particular medications, because they are summary-level data at the inpatient stay or outpatient encounter level, and hence a single record may reflect multiple prescriptions.

The PBM database and VISTA are also the best sources of information on dispensing details. Basic elements include the prescription fill date, total quantity dispensed, dispensing unit, and days supplied. Additional VA administrative elements include the indicator for new, refill or partial refill prescription, the mode of pickup, and whether the patient was offered and accepted counseling.

A very unusual feature of PBM and VISTA is the availability of dosing instructions. The wording of dosing instructions has not been standardized, however, and many are written with medical abbreviations, such as "T2T QID PRN" and "APPLY EXT TAA BID UD." Working with dosing instructions as research data is painstaking but yields information available from no other source. Research uses include studies of patient or caregiver adherence to physician instructions and the relation between physician intentions (as expressed in the dosing instructions) and the actual medication forms dispensed by the pharmacist. To identify cumulative exposure to inhaled corticosteroids in a cohort of patients with chronic obstructive pulmonary disease, VA researchers are using the dosing instructions field in VISTA to identify the number of doses prescribed and the frequency of administration. They are combining this information with the dose of the medication dispensed to estimate the total dose of inhaled corticosteroids consumed over a defined time period.[7]

The DSS National Pharmacy Extract contains two dispensing details at present, the fill date and the total quantity dispensed. Additional elements planned for future updates include days supplied, new fill/refill indicator, and pickup indicator. The DSS NDEs for discharge, treating specialty, and outpatient data provide only the date of the inpatient stay or outpatient encounter that included pharmacy service. That is, they record whether or not pharmacy costs were assigned to the particular stay or encounter, but not details of the pharmacy services provided.

## COST DATA—SOURCES

Several elements contribute to the recorded price of a prescription. VISTA pharmacy modules have three key variables: (1) the price per dispensed unit from FILE 50; (2) the quantity dispensed from the VISTA Pharmacy package; and (3) the total cost, defined as the product of the first two.

A single NDC has up to five purchase prices (acquisition costs) associated with it. Three are federal-wide, and two are VA-specific. The federal-wide costs come from the Federal Supply Schedule (FSS), the FSS Tier schedule, and the federal ceiling price (FCP, or "Big 4") schedule available to VA, the Department of Defense, the Coast Guard, and the Public Health Services (U.S. General Accounting Office 2000). The two prices specific to VA come from the agency's National Contracts and Blanket Purchase Agreements (BPAs). About 3 percent of VA medication expenditures occur at market prices, outside of a PBM national contract or federal schedule. Costs for noncontract medications will vary by facility and by purchase date.

The cost associated with an NDC usually varies across schedules. On one day in September 2002, for example, a package of five insulin lispro 100 (Humalog®) pens ranged from $51 to $61 on the FSS, FSS Tier, and FCP schedules; a package of 1,000 olanzapine (Zyprexa®) 20 mg tablets cost roughly $13,000 on the FSS and $10,800 on the FCP.[8]

Changes in drug costs are recorded in VISTA FILE 50 following manual updates from the VISTA Drug Accountability Package (DAP). The updates are not automatically reflected in a facility's VISTA system, however. A local pharmacy employee must run the DAP software to obtain the most recent prices. Contract changes occur year-round, and so the cost schedules change on nearly a daily basis. Due to staffing limitations, local DAPs generally are not updated daily (Cunningham, Sales, and Valentino 2001). The cost assigned to a prescription in a local VISTA system, therefore, may not reflect the most current price. The overall effect of such errors in drug prices is unclear because costs can rise or fall as contracts are renegotiated.

Using the NDC field, one can link PBM data to other databases to find commercial costs such as average wholesale price (AWP), maximum allowable cost (MAC), or wholesale acquisition cost (WAC). To estimate VA drug expenditures, use only official VA drug costs (available on the PBM Web site, www.vapbm.org). Substantial errors can arise if AWP or other commercial costs are employed. For example, the 1998 VA cost for an annual supply of the cholesterol medication gemfibrozil ($46.75) was less than one-twentieth of the AWP for the same agent, Lopid ($956.96) (Nyman et al. 2002). AWP and other commercial costs may be useful, however, for simulating the cost of an intervention outside the VA.

## COST DATA—VARIABLES

VISTA and PBM feature the purchase (schedule) price of the dispensed medication, as just described. DSS sources do not contain the schedule price but nevertheless provide a wealth of information on direct and indirect costs.[9] Direct costs are those specifically related to patient care, such as salaries and the purchase price of medications. The fixed direct cost does not vary with the volume of services. The variable direct cost consists of items that vary with the volume of services, including the acquisition cost of the medication or supplies dispensed. Indirect costs represent expenditures that cannot be tied to specific services, such as property acquisition and maintenance.[10] The sum of fixed direct, variable direct, and indirect costs is the total cost.

The DSS NDEs for inpatient and outpatient care feature an average dispensing cost for the facility. This average cost will vary across fiscal years and facilities. Actual dispensing cost would be difficult to measure, as it would depend on where the order was filled (local pharmacy or CMOP), type of medication or supply, staffing cost, and other factors.

Variable supply cost is an estimate of the cost of all supplies used by the pharmacy for the patient on a given day. It is calculated as the variable direct cost multiplied by an adjustment factor. (See Yu and Barnett [2002a] for details of its calculation.) The adjustment factor is fixed for all outpatient pharmacy records for a particular medical center in a fiscal year. The adjustment factor is based on an assumption that the variable nonsupply cost of each record is proportionate to the supply cost.

## CLINICAL DATA

Researchers often wish to link prescriptions to clinical data. A study of adherence to clinical practice guidelines for heart disease, for example, would require a linked dataset containing information on prescription drugs,

inpatient and outpatient services, diagnoses, and procedures. The data sources in Table 2 either contain nonprescription data elements or can be merged with such data from other VA sources.

It is not surprising that VISTA is the best source of clinical data, since one of its functions is to support CPRS, the means by which providers and other VA staff create a patient's electronic medical record. The usefulness of VISTA for research, however, is limited by the inconvenience of performing separate extractions at each VA medical center.

More convenient are the DSS NDEs for inpatient and outpatient care. These contain the clinic code, which identifies outpatient clinics, and the DSS-specific department number, a second way to track the location of care. They also feature the primary diagnosis code, if any, associated with the outpatient visit. The NDEs for inpatient and outpatient care list primary procedure as well. Any additional diagnosis and procedure codes may be found by linking to the Medical SAS Datasets of inpatient and outpatient care.

Other pharmacy data sources have less clinical information. The DSS National Pharmacy Extract features the primary diagnosis code but no procedure codes. The PBM database contains no information on patient clinical characteristics. Both sources can be linked to Medical SAS utilization data using the date, location, and patient SSN. Such linkage does not make it possible, however, to attribute a prescription to a particular clinic code or diagnosis, if more than one appeared on the outpatient record for a given day.

Many researchers would find it useful to link prescription data to laboratory and radiology test results. DSS NDEs for laboratory and radiology tests were recently developed. They do not contain results, but simply record the fact that a test occurred. The files may be linked to other data sources by patient ID and date. The DSS Program Office is developing a new NDE that will feature laboratory test results. A similar process is under way for PBM.

Inpatient clinical data are available in VISTA, the planned DSS National Pharmacy Extract, and the DSS NDE for inpatient care. All three sources contain the admission and discharge dates, the treating specialty, and bedsection (ward). VISTA contains all diagnosis and procedure codes associated with a given inpatient stay, but the DSS NDEs for inpatient care have only the primary diagnosis code and no procedure codes. Similarly, the planned DSS National Pharmacy Extract will feature only the diagnosis code for the treating specialty during which the prescription order occurred. Additional diagnosis and procedure codes could be obtained by linking the DSS sources to the Medical SAS Datasets for inpatient care. The overlap between the Medical SAS Datasets and the DSS inpatient and outpatient NDEs is not perfect, however (Yu and Barnett 2002a, 2002b).

## PATIENT DEMOGRAPHICS

Researchers may want to stratify prescription drug use by patient characteristics, such as for studies of racial and ethnic differences in treatment patterns or outcomes. VISTA contains all such information collected by VA providers and staff, including many more items than are listed in Table 2. For example, through VISTA one can learn the patient's disability status, service connection (0%-100% or none), and military service details such as dates, places, and branch of service. Medical information such as height and weight may be found in the VISTA Vitals/Measurements package.

PBM and the DSS sources vary considerably in their coverage of demographic information. The PBM outpatient database contains only the patient SSN, although one can use it to link to demographic data in other sources. An updated PBM database now under development will include additional demographic and clinical data. The DSS NDEs for inpatient and outpatient care contain SSN, date of birth, age, and gender. The planned DSS National Pharmacy Extract will contain a wealth of data on patient characteristics. In addition to the patient ID (SSN), it will feature gender, date of birth, low-income status (based on the local threshold for federally subsidized low-income housing), and home zip code.

## PROVIDERS/PHYSICIANS

A number of studies have tested the hypothesis that provider characteristics affect prescribing patterns, including Mark et al. (2002) and Newton et al. (2001). Such research is possible with VA pharmacy data sources, which offer an array of data fields pertaining to prescribing physicians and primary care providers.

VISTA is once again the richest source of information. It features data on the prescribing physician and the patient's primary care team. Variables include the provider ID, an indicator of VA affiliation, provider type, class, service or section, and medical specialty and subspecialty. The provider ID is a created number unique to the VA facility. Provider type indicates the physician's status as a VA staff member or a non-VA Fee Basis provider (see Other Sources, below). The class is the physician's degree type, such as MD or DDS. Examples of VA services and sections are psychiatry, surgery, and medicine. The specialty refers to the provider's medical specialty, such as internal medicine or oncology.

The other data sources provide somewhat less detail on providers. The PBM database is strongest for provider information but contains no details on primary care providers. The DSS NDEs for inpatient and outpatient care

provide considerable detail on primary care providers but little information about the prescribing physician, and the planned DSS National Pharmacy Extract will do so as well.

### PHARMACY CHARACTERISTICS

Each of the data sources offers some information on the pharmacy that provided the prescription. Each identifies the facility ID, or station number, that references the VA medical center. VISTA and the DSS NDEs for inpatient and outpatient care further identify which of 21 regional networks, or VISNs (Veterans Integrated Service Networks), it belongs to. Tens of thousands of VA prescriptions every day are filled by CMOPs, the VA regional automated pharmacies. The DSS outpatient NDEs and VISTA identify whether a CMOP was the source of a prescription. The same information may be obtained in PBM through the pickup indicator: a value corresponding to mail delivery indicates that a CMOP filled the order. A similar indicator is planned for the DSS National Pharmacy Extract.

## OTHER SOURCES

### DSS PRODUCTION DATA

The DSS production databases at VA medical centers contain prescription-level records. They can be used to generate clinical and cost reports of medical center pharmacy and other services, although generally they are not directly accessible by researchers. DSS reports can be requested from local DSS staff, but researchers may be charged for computing costs. The DSS National Pharmacy Extract currently under development will feature detailed prescription level data and, thus, will make it less likely that researchers will need to obtain data from the local DSS databases.

### FEE BASIS FILES

When VA facilities cannot provide needed care or when a non-VA facility can provide care more economically, the VA may pay for care at a non-VA facility. These services fall under the Fee Basis Program, which covers inpatient care and outpatient medical and dental care. Pharmacy services are part of the Fee Basis program. Fee Basis pharmacy payments totaled $765,000 in FY1998, including $282,000 for reimbursement to veterans and $483,000 for direct payments to pharmacies. Although this represents a small fraction of total VA

pharmaceutical spending, which totaled over $1.5 billion in FY1999, the Fee Basis files complete the picture of VA pharmacy services.

The Fee Basis data are maintained in seven files pertaining to inpatient hospital stays, inpatient ancillary services, outpatient services (other than pharmacy services), pharmacy services, travel expenses, and two for miscellaneous payments (to other vendors and to Fee Basis ID card holders). A separate set of files is created for each fiscal year.

The Fee Basis Payments to Pharmacies file contains a record of each outpatient prescription from a non-VA pharmacy paid under the Fee Basis program. Data elements include the fill date, amount claimed, and amount paid, but not drug-specific characteristics such as NDC, drug name, or days supplied. Using the patient's scrambled SSN, the Fee Basis pharmacy file can be linked to other Fee Basis files and to national utilization data in the Medical SAS Datasets. Thus, total outpatient prescription drug costs can be determined, although costs cannot be ascribed to particular medications. Fee Basis inpatient pharmacy costs cannot be separated from other inpatient costs.

VA will pay for prescriptions from community pharmacies only when the medication is for treatment of service-connected conditions. Veterans who obtain prescriptions from non-VA pharmacies without prior arrangement will be reimbursed only if the prescribing non-VA physician deems them necessary for treatment of authorized conditions and the situation is urgent or emergent. Reimbursement is limited to the amount sufficient to purchase a 10-day supply of the medication. In all cases, the VA payment will be a function of the medication's average wholesale price plus the state-specific Medicaid dispensing fee.

The Fee Basis files will be useful either as an adjunct to other sources or for studies of the Fee Basis program itself. Patients whose non-VA care appears in the Fee Basis files will also appear in other VA databases if they receive care at VA facilities. Users should also note that the VA is planning to alter or replace the system so that Fee Basis transactions will be recorded in DSS. The date of the transition is unknown at this time.

## PHARMACY COPAYMENTS

VA charges a copayment for outpatient prescriptions when the supply lasts 30 days or less and the medication is not for a service-connected condition. In calendar year 2002, the patient's copayment was $7 per prescription. Certain veterans are exempt from copayment, such as those with service-connected disabilities rated 50 percent or greater, and those with income below the VA pension level (U.S. Department of Veterans Affairs 2002).

The pharmacy data sources described in this article do not explicitly record prescription copayments. The pharmacy costs they report are from VA's perspective rather than the patient's. Categorical exemption from copayment can be determined from electronic data sources, however. Low-income status is indicated by a means-test variable in VISTA and the planned DSS National Pharmacy Extract. Both the means-test indicator and percent service connection are available in the standard inpatient and outpatient utilization files, the Medical SAS Datasets. Information on those datasets is available on the VIReC Web site.[5]

## DATA QUALITY

### MISSING DATA AND CONSISTENCY CHECKS

VA pharmacy data will inevitably contain some missing or erroneous values. We strongly recommend producing frequency distributions and descriptive statistics before using pharmacy data for analyses. This approach will identify, for example, NDCs beginning with 00000 or 99999, values for days supplied and quantity supplied that are not integers greater than 0, and unit or total cost ≤ $0. Records with these values should not be discarded without investigation; it may be possible to rectify an obvious error using other data on the record.

A potential hazard in using total quantity dispensed is the variation across facilities in the assignment of dispensed units. For example, a 50 ml injection may be recorded at one facility as 50 units and at another as one unit. In theory, the two may be reconciled based on other information on the record, such as the NDC or dosage instructions. One approach to locating such variations is to tabulate the range of dispensed units for selected NDCs.

Checking the validity of cost data may be complicated. One could in theory observe two prices for a single NDC on the same day simply because one facility had not updated its DAP. Likewise, blanket purchase agreements may cause a disparity in price between two facilities on the same day for the same product. Again, univariate statistics can alert researchers to outlying values. Substantial cost variation across facilities and across time within a single facility should be investigated. For many applications, replacing the facility's cost values with the end-of-year national value would be acceptable. In other applications, variance throughout the year reflects true variation that should be preserved.

Several options exist for handling erroneous or missing values in pharmacy data. Costs and dispensing unit (mg, ml, etc.) may be filled in through refer-

ence to other prescriptions for the same NDC. For cost it is preferable to use data from the same facility and about the same time. The NDC corresponds to a particular package size as well, thereby providing a potential alternative source for the number of units dispensed. In some cases, less than an entire package is dispensed, however. Checking for similar prescriptions for the same patient is advisable.

Although NDCs represent the most precise way to identify medications, the NDC listed on a VA record may not be the NDC from which the order was filled. If there are multiple manufacturers (as for generics), a single NDC in the VA record may be used to represent all similar combinations of product, strength, and dosage form from all manufacturers.

For branded medications, a single NDC in the VA record may represent all package sizes for the same combination of product and strength. For example, a single NDC is used for sildenafil citrate (Viagra®) 50 mg, although prescriptions for it may be dispensed from two different package sizes (30 or 100 tablets), each of which has a separate official NDC associated with it. The VA National Drug File lists every official NDC associated with each VA product name.

## VALIDATION

A primary method for determining the quality of database information is to verify it against a standard known to be accurate. VISTA is the primary source of clinical data in VA. There is no written patient record against which to validate VISTA because providers enter information directly into the system. In theory, it could be compared to observational data, but we are aware of no such studies.

Some VISTA fields are allowed to vary across sites. The dispensed-units field, for instance, is created by each pharmacy without the benefit of unifying national guidelines. The problem is most often for topicals, liquids, and aerosols, although even for these products, mail-order prescriptions generally have reliable data.

We are not aware of studies validating DSS national extracts against VISTA, but the DSS system appears to capture utilization well. Yu and Barnett (2002a, 2002b) compared the DSS discharge, treating specialty, and outpatient NDEs to the Medical SAS Datasets of inpatient and outpatient utilization. The count of inpatient visits was very similar in the two sources. Outpatient non-pharmacy visits diverged by several percentage points. Outpatient pharmacy records could not be directly compared due to differences in the method of counting visits: the DSS system includes pharmacy visits even if the patient

did not see a provider, whereas the Medical SAS Datasets count only visits that involve a provider.

The outpatient NDE datasets include some services not reported in the VA Medical SAS Datasets for outpatient care, the primary source of VA outpatient care utilization data. These additional records represent events that cannot be tied to a specific visit, such as when a patient fills a prescription at a VA pharmacy but obtains no medical services on that date. Yu and Barnett (2002a) detailed how indicator variables may be used to identify records representing visits to the "pharmacy clinic."

The quality of DSS cost data is less known. Data quality is believed to be higher at VA facilities where implementation of the databases began earlier, and overall it is thought to be improving each year. Researchers interested in using DSS cost data from a single facility, particularly data from FY1999 or earlier, are advised to ask the local DSS managers and the VA DSS Program Office about data quality.

A number of evaluations have been carried out by the PBM/SHG field office and others in which PBM data were compared to separate data sources at individual facilities. In one, the PBM database was found to include at least 99 percent of all outpatient prescriptions.[11] As noted below, studies such as these represent an important area for future research.

Accurate interpretation of prescription records is improved by reference to the National Drug File, which was developed by PBM/SHG to match locally assigned drug names (station names) to agency-wide standard names (VA Product Names). The file contains other information as well, such as NDC, package type, strength, dispensed units, and VA drug class. The National Drug File, which is updated every 2 months, may be downloaded from the PBM/SHG intranet Web site.

## DISCUSSION

The VA pharmacy data sources described here have great potential for use in health economics and health services research. The number of published studies employing these sources is small but growing rapidly. The range of subjects addressed is broad, encompassing prospective and retrospective studies of health outcomes, cost-effectiveness and other health economics analyses, quality of care studies, and health systems research. Studies also have illustrated the usefulness—and frequently the necessity—of combining data from multiple sources.

Many studies have extracted data directly from VISTA, usually in conjunction with other data. Keiser et al. (1999) studied the impact of a pharmaco-

therapy for HIV at a VA medical center. Prescriptions and other utilization data were drawn from the medical center Immunology Case Registry, a VISTA module. The authors determined average cost of care by combining the VISTA data, HIV-related workload from a department survey, and costs from the medical center's fiscal service. Weaver and colleagues extracted inpatient unit dose and intravenous antibiotic therapy from VISTA for patients with urinary tract infections.[12] By using the PBM database to track outpatient antibiotics and UTI-related medical supplies (catheters, as a measure of bladder management), the authors were able to determine the impact of antibiotic therapy and bladder management on type of UTI. Hynes, Joseph, and Pfeil (2002) list additional studies making use of data extracts from VISTA.

A number of studies have used PBM data, most focusing on mental health. Outcomes studied include the relationship of antipsychotic dosing to recommendations from the schizophrenia Patient Outcomes Research Team (PORT) (Leslie and Rosenheck 2001b), the link between second-generation (atypical) antipsychotics and the presence of diabetes mellitus (Sernyak et al. 2002), the connection between fiscal stress at the provider facility and the probability of receiving first-generation (typical) versus second-generation (atypical) antipsychotics (Leslie and Rosenheck 2001a), and how well medication adherence predicts the likelihood of inpatient admission (Valenstein et al. 2002).

Data from the DSS system have been used in only a few published studies. Barnett et al. (2002) employed the DSS NDE for inpatient care to estimate total spending among patients with myocardial infarction. Maciejewski et al. (2002) used the DSS NDEs for inpatient and outpatient care to find direct costs for primary care, including pharmacy. By using DSS, the authors were able to estimate direct costs separately from indirect costs. As they noted, the components of indirect cost varied by facility. An analysis that includes indirect costs should take account of the variability in accounting practices across VA facilities.

## CHOOSING A SOURCE

Considerations when choosing a VA pharmacy data source include the data elements needed, the time and effort that can be spent obtaining the data, and the level of aggregation desired. Table 3 summarizes the content of the pharmacy data sources described above, listing the events covered, data format, record level (prescription vs. encounter), and advantages and disadvantages.

Researchers needing details of medications and prescriptions will need to use PBM or VISTA as their data source. Obtaining data from VISTA is significantly more difficult, and so, unless additional clinical data are needed, the PBM database will be the better choice. The trade-off between time and

TABLE 3 Summary of VA Pharmacy Data Sources

| *Source* | *Events Covered* | *Data Format/ Record Level* | *Advantages* | *Disadvantages* |
|---|---|---|---|---|
| VISTA | All health care utilization at one facility | ASCII/patient-level inpatient stay or outpatient event | Greatest detail of personal and utilization characteristics | Requires specialized programming, permission by each facility, and careful interpretation across facilities |
| PBM | All pharmacy products | several formats[1]/product | All prescription characteristics, national coverage | Limited demographic and clinical information |
| DSS Inpatient/ Outpatient NDEs | All health care utilization | SAS®/patient-level inpatient stay or outpatient event | National coverage, summary cost data | Limited prescription characteristics |
| DSS National Pharmacy Extract (planned) | All pharmacy products | SAS®/product | National coverage, cost at product level | Limited prescription characteristics |

Note: PBM = Pharmacy Benefits Management; NDE = National Data Extract; VISTA = Veterans Health Information Systems and Technology Architecture; DSS = Decision Support System.
1. Options include SAS® and Microsoft Access® or Visual FoxPro®.

money also may be a consideration. VISTA data are free but require special permissions and programs. PBM data are extracted by the PBM/SHG staff and so require relatively little effort, but funded studies will be charged for their assistance.

Another axis of choice pertains to characteristics of the cost data available. Only DSS estimates a total cost, including indirect costs and direct costs beyond the purchase prices of medications and supplies. Thus, researchers studying the total cost of VA pharmacy care (or of all VA care services) must rely on the DSS extracts or else must estimate the other cost factors by another means.[13] Because they are estimates, the researcher must bear in mind that a different method of estimating costs, such as another way of allocating overhead to particular services, would yield somewhat different costs, particularly indirect costs.

The level of data aggregation to be used may guide the choice of data source. VISTA, PBM, and the DSS local databases can be used for prescription-level research, and these data may be aggregated into encounters with relative ease. The DSS NDEs for inpatient and outpatient care are already organized by encounter, and so all of these data sources are appropriate for studies of utilization at the encounter level and higher.

## SYSTEMATIC LIMITATIONS OF VA DATA

Limitations in the PBM and DSS data can often be overcome by linking data from multiple sources. Clinical information such as treatments and diagnoses are available in the VA Medical SAS Datasets for inpatient and outpatient care. Yu and Barnett (2002a) described the method for linking these sources to the DSS NDEs for inpatient and outpatient care. The lack of detailed information on characteristics of individual prescriptions can be overcome either by supplementing the NDEs with an extract from the local DSS production data system or by sending the PBM staff the study individuals' encrypted SSNs and obtaining an extract from the PBM database.

VA data inevitably reflect VA practice patterns. This is clearest in the cost fields, which are frequently specific to individual VA facilities. A more subtle connection concerns the mix of therapies used to treat specific illnesses. For example, a capitation-based funding system coupled with substantial negotiated discounts on antidepressant medications could lead VA providers to favor medications over office-based psychotherapy, all else equal. If so, then extrapolating antidepressant prescribing patterns to non-VA providers that do not enjoy the same level of discounts could overstate the likely cost of antidepressants for those providers.

The time and effort needed to obtain permission to access the data sources described earlier will not be trivial, especially for non-VA researchers. Moreover, the sources are frequently revised to add, drop, or modify data elements. To avoid the cost of changing sources midstream, it is advisable to obtain current listings of data elements before choosing one for a research project. VIReC has placed information materials on its Web site pertaining to DSS, the PBM database, and other VA utilization files.[5] Specific questions about PBM data may be addressed to the PBM/SHG staff.[3] The Fee Basis files are described in the *Fee Basis Guidebook*, available from the VA Health Economics Resource Center (HERC).[13]

A final issue concerns patients' dual use of VA and non-VA systems. The VA's relatively generous pharmacy benefits are known to attract users who wish to supplement their Medicare coverage. More than 50 percent of VA enrollees have Medicare coverage, including 22 percent of those under age 65 (Shen et al. 2003). As a result, one cannot rely on VA sources alone to present the entire picture of health care services for VA patients. One option is to limit analyses to the realm of VA health care. VA is of interest due to its large patient population, nationwide representation, and federal funding, and many studies focus on VA services for these reasons. Another option is to obtain Medicare records for VA patients, linking them to VA encounter data through SSNs.[14] This provides a more complete picture of health services and enables research on movement between alternative systems of care.

## AREAS FOR FUTURE RESEARCH

Reports of successes and difficulties in using the VA pharmacy data for typical health services research, such as outcomes studies, would benefit future investigations. Data quality is an important area for research, particularly due to the recent and ongoing development of these pharmacy data sources. The usefulness of VA pharmacy data sources would be improved by research on data quality and comparative studies of alternative pharmacy data sources.

Potential research topics include comparisons of DSS and PBM extracts to a benchmark data source; analyses of changes in data quality over time; explanations of changes in the range and construction of data elements, particularly those pertaining to costs, medication identifiers, and prescription characteristics; comparisons of data quality across types of medication and across facilities; and studies of data quality for nonprescription pharmacy supplies, both generic medications and nonmedication supplies.

A natural question is what to use as the standard of comparison. Although direct measurement of pharmacy data is possible in theory, it would likely be less accurate than VISTA. A pharmacy survey completed by patients would be

subject to the limitations of cognitive ability and poor recall. And there are too many pharmacies and too many prescriptions to make direct observation of pharmacy transactions a realistic method. For these reasons, VISTA must stand as the most reliable source of pharmacy data.

As noted earlier, prescription cost data for PBM comes from the Drug Accountability Package (DAP) in VISTA. Although updates to contract prices occur nearly every day, in practice, VA pharmacists report that they update their local DAP less frequently, sometimes no more than monthly. An important area for research is the extent to which drug costs in VISTA (and hence the PBM and DSS databases) are misreported as a result.

Many researchers will want to link pharmacy data to other utilization data, to patient demographics and clinical characteristics, to administrative data on facilities, and perhaps to other data types as well. As health services research using linked pharmacy data is carried out, it would aid the research community if authors would report their experiences in matching records across data sources. Yu and Barnett (2002a, 2002b) provided examples of this type of study. Outcomes of interest include the proportion of people and the proportion of records that can be linked, what difficulties were found in linking (such as missing values or differences in database formats), and how such difficulties were overcome or avoided.

## NOTES

1. MUMPS is a registered trademark of the Massachusetts General Hospital Corporation.
2. Microsoft, SQL, Access, and Visual FoxPro are registered trademarks of Microsoft Corporation in the United States and/or other countries. SAS and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc. in the USA and other countries. ® indicates USA registration.
3. See the PBM Web site at www.vapbm.org for information on contacting the PBM/SHG and completing a PBM Data Request Form.
4. Personal communication from Michael Valentino, PBM/SHG.
5. The VIReC Web site address is www.virec.research.med.va.gov. The VIReC help desk e-mail address is virec@research.hines.med.va.gov.
6. The VA product name is unique if there is a single supplier, as for branded medications. If there are two or more suppliers, a single VA product name may apply to all.
7. Personal communication from Todd Lee, Midwest Center for Health Service and Policy Research, Edward Hines Jr. VA Hospital, Hines, IL.
8. From price schedules on the PBM/SHG Web site.
9. Researchers interested in the cost of VA pharmacy will want to use only the September DSS files. Cost figures for the fiscal year are finalized in the September files. And

because the DSS files are cumulative within each fiscal year, only the September files provide information spanning an entire year.

10. The DSS system allocates indirect costs according to a several-step procedure. See Barnett and Rodgers (1999) for an overview and chapter 3 of Yu and Barnett (2002a) for details.
11. Personal communication from Francesca Cunningham.
12. F. M. Weaver, C. T. Evans, G. J. Joseph, J. P. Parada, J. S. Wheeler, S. Sabharwal, B. Nemchausky. "Management of frequent urinary tract infection in veterans with spinal cord injuries and disorders." Manuscript under review.
13. See the HERC (Health Economics Resource Center) Web site at www.herc.research.med.va.gov; herc@med.va.gov.
14. Under a Memorandum of Understanding between Health and Human Services and the Department of Veterans Affairs, VIReC is preparing linked files of VA and Medicare data beginning with 1999. Announcement of the availability of datasets with merged VA-Medicare data is expected during the fourth quarter of FY2003. For information, contact VIReC at virec@research.hines.med.va.gov.

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# Determination of VA Health Care Costs

*Paul G. Barnett*
VA HSR&D Health Economics Resource Center,
VA Cooperative Studies Program, and Stanford University

*In the absence of billing data, alternative methods are used to estimate the cost of hospital stays, outpatient visits, and treatment innovations in the U.S. Department of Veterans Affairs (VA). The choice of method represents a trade-off between accuracy and research cost. The direct measurement method gathers information on staff activities, supplies, equipment, space, and workload. Since it is expensive, direct measurement should be reserved for finding short-run costs, evaluating provider efficiency, or determining the cost of treatments that are innovative or unique to VA. The pseudo-bill method combines utilization data with a non-VA reimbursement schedule. The cost regression method estimates the cost of VA hospital stays by applying the relationship between cost and characteristics of non-VA hospitalizations. The Health Economics Resource Center uses pseudo-bill and cost regression methods to create an encounter-level database of VA costs. Researchers are also beginning to use the VA activity-based cost allocation system.*

***Keywords:*** *cost; economics; billing; charges; reimbursement; average costs; micro costs; veterans; VA*

Economics is an increasingly important part of health care decision making. Accurate determination of health care cost is an essential part of this process. This article provides an overview of methods of determining the cost of

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services provided by one of the nation's largest integrated providers of care, the U.S. Department of Veterans Affairs (VA).

VA operates a national network of hospitals and clinics. Clinical trials and health services research are important missions in the VA system. These studies are facilitated by an advanced system of electronic medical record keeping and by national databases of health care use. Health economists normally use billing data to estimate the cost of many U.S. health services, but VA does not routinely bill patients for their care. In the absence of billing data, economics researchers have developed alternate strategies for estimating the cost of VA services. This article describes these strategies, with emphasis on recent improvements to VA cost determination data and methods.

Cost determination relies on systems of financial and utilization data. To provide the reader with essential background, this article begins by describing VA cost and utilization databases. The article then turns to its focus: five different methods of finding the cost of VA health services. The first method described is direct measurement, a method that is especially valuable for determining the cost of new interventions and care unique to VA. The next method is itemized list costing, also known as the pseudo-bill method. This method relies on utilization data and a charge or reimbursement schedule from outside VA to estimate cost. The third method is cost regression. A regression is used to determine the relationship between the cost and characteristics of non-VA hospital stays and apply it to VA data. Two new VA encounter-level cost data sources are described. This description is followed by a discussion comparing the alternative methods and data sources and a presentation of plans to improve the accuracy of VA utilization data and cost estimates.

## NEW CONTRIBUTION

This article updates a previous review of VA cost determination methods (Barnett 1999) with information on improved methods, newly published studies, and two new sources of VA cost data. These are the average cost data sets created by the VA Health Economics Resource Center (HERC) and the national extracts of the Decision Support System (DSS), an activity-based cost system implemented by VA. These new cost data sets are easier to use than the traditional methods of finding VA costs. Researchers are provided with recommendations about the appropriate use of each method and source of cost data.

## VA COST AND UTILIZATION DATA

This section provides the reader with essential background on VA databases used to determine the cost of VA care. It describes VA's general ledger, department cost allocation system, and national utilization databases.

VA tracks its health care expenditures in a general ledger and a cost allocation report. The VA general ledger is called the Financial Management System (FMS). FMS reports the cost of supplies and the quantity and cost of each type of staff at each medical center. Expenses are tracked by cost center, an accounting category that corresponds to a VA administrative unit such as the medical, nursing, or psychiatry service. Cost centers do not correspond to patient care departments. For example, the nursing service cost center does not distinguish the nursing costs of inpatient wards from those of outpatient clinics.

VA has a cost allocation system that estimates the cost of each department at each VA medical center. It is called the Cost Distribution Report (CDR). CDR is based on time allocation estimates of VA service chiefs. For example, the head of nursing service estimates the number of staff assigned to different wards and clinics. These estimates are used to allocate personnel costs reported in FMS to cost distribution accounts in CDR. CDR accounts correspond to departments that provide patient care; additional accounts provide the cost of administrative overhead and facility support. CDR does not completely distribute overhead to patient care departments. It does reconcile to FMS, and it is the only historical source of department-level estimates of VA costs, but concerns have been expressed that CDR may not be accurate or up to date (Swindle, Beattie, and Barnett 1996).

VA has adopted one of the nation's most sophisticated systems of electronic medical records. Called the Veterans Integrated Health Systems Technology & Architecture (VISTA), it contains detailed clinical and utilization data. This system is decentralized; each VA medical center and health care system operates an independent computer system. Because of this, there is no single access point to VISTA. To extract data from these records requires cooperation from some 140 VA health care systems, each with its own independent human subjects review panel. Fortunately, VA extracts data from the VISTA system and uses it to create inpatient and outpatient utilization data sets.

The patient treatment file (PTF) is a database of hospital discharges. It characterizes patients and all care involving an overnight stay in any VA facility, including acute medical and psychiatric hospitalizations, rehabilitation, long-term care, residential stays, and domiciliary stays. The PTF also includes care provided in observation units; this care does not ordinarily involve overnight stays.

The outpatient care file is a database of outpatient visits provided by VA. It includes patient demographics and characterizes encounters with diagnosis and procedures codes.

The VISTA system is also extracted to create national databases on pharmacy, prosthetic devices, and contract care. It is also the source of much of the data in DSS, the activity-based cost allocation system described below.

## DIRECT MEASUREMENT

Direct measurement is a useful and potentially accurate means of determining health care cost. This method is ordinarily used to determine the cost of new interventions and programs unique to VA. It can be used to find the cost of a diagnostic test, procedure, or other service. Direct cost measurement methods have been used to find the cost of innovative interventions, including adult day health programs (Chapko et al. 1993) and specialized geriatric (Toseland et al. 1997) and hypertension clinics (Stason et al. 1994). Another article in this issue describes this method and its application to the VA in greater detail (Smith and Barnett 2003 [this issue]).

To find the cost of a unit of service, the total direct cost of providing the service is divided by the number of units of service produced. An activity analysis is used to determine the quantity of labor employed. The analyst may directly observe staff time, have staff keep diaries of their activities, or conduct a survey of managers. The cost of each type of staff is determined from accounting data, such as FMS.

The cost of capital can sometimes be found by surveying the market to learn rental rates (Rosenheck, Frisman, and Neale 1994). It is not possible to use this method to find the capital costs of every service. For example, there is no rental market for hospital operating rooms.

The volume of services may be obtained by survey or from administrative records. For example, the unit cost of a visit to a specific outpatient clinic is found by dividing the total cost of the clinic by the number of outpatient visits that it provides.

The analyst may need to find the unit cost of several different health care products. It is often not appropriate to assume that all products have the same cost. In the above example, some visits to the clinic might last 15 minutes and others an hour or more. When heterogeneous products are produced, the analyst may use direct measurement methods to find the relative quantity of resources used in creating each health care product. A charge or reimbursement schedule might also be used as the measure of relative value, but this requires the assumption that the schedule has the correct values for the ser-

vices being studied. Regardless of the source of relative values, determining the cost of any product requires that the analyst find the average cost per unit of relative value. This requires that the analyst determine a relative value and find the total quantity of every service of the program being studied.

Direct measurement of cost has the advantage that it does not rely on the assumptions required by other cost methods. The drawback to this method is that it is labor intensive. Because of the diversity of health care, few studies rely entirely on the direct measurement method. Other methods are used to measure overhead costs or other health care costs incurred by patients.

The overhead associated with providing patient care includes the cost of services such as administration, housekeeping, maintenance, medical records, and other departments that support patient care. Although a direct cost study can determine the cost and workload of a specific program or department, when care is provided in a hospital, it is beyond the scope of most studies to directly measure the cost of all departments and how much overhead should be distributed to each. Most analysts turn to a hospital cost report for this information. There are two possible sources of VA data: CDR and DSS department-level cost data.

Direct measurement may be used to find the cost of a new intervention. Since cost-effectiveness analysis is concerned with the impact of the intervention on all health care cost, the analyst must also gather information on subsequent ambulatory care, hospital stays, long-term care, and other services used by study participants. Because of the expense of direct cost measurement, other methods are used to find these costs. These methods are described below.

## ITEMIZED LIST COSTING (PSEUDO-BILL)

The second cost determination method considered in this article combines utilization data with a reimbursement or charge schedule. The resulting list of services used by a specific patient is analogous to the itemized bills of health care providers. As a result, this method is sometimes referred to as the "pseudo-bill" method. The unit cost of each item may be the Medicare reimbursement rate, the charge rates of an affiliated university medical center, or some other non-VA source. This method has been used in a variety of studies, to find the costs associated with Alzheimer's disease (Volicer et al. 1994), colon cancer (Wade et al. 1996), and heart disease (Kessler, Kessler, and Myerburg 1995).

Since outpatient bills are considerably less complex than bills for hospital stays, this section first considers construction of a pseudo-bill for outpatient services. It considers the physician bill and then describes how a pseudo-bill

can be constructed for the ambulatory care provided by health care facilities, such as hospital-based emergency rooms and clinics, ambulatory surgery centers, and freestanding diagnostic centers. The discussion then turns to creating pseudo-bills for the hospital and physician components of inpatient hospital stays.

**Outpatient Pseudo-Bills**

VA characterizes outpatient services using the same codes that private U.S. providers use to bill for their services, making it possible to create a pseudo-bill for VA ambulatory care that is analogous to a private sector bill. VA uses current procedures and terminology (CPT) codes to characterize services provided by physicians and other providers. It uses Medicare Health Care Procedures Coding System codes to characterize medical supplies, devices, and certain specialized services. Medicare and other health care payers have reimbursement schedules that are based on these codes. Medicare reimbursement rates are the most accessible, as they are public and well documented. Medicare is a national program that accounts for a substantial portion of U.S. health care expenditures; other health care payers often follow Medicare payment methodologies.

Yet Medicare charge schedules do not include reimbursement rates for all types of care provided by VA, for example, preventive services, dental procedures, and telephone consultations. The charge schedules of other payers are needed to prepare a pseudo-bill for these services.

It is important to note that Medicare provides higher physician payments when services are provided in a doctor's office than when they are provided in a health care facility. The office-based physician is reimbursed for both physician services and practice expense. When care is provided in an outpatient facility, such as a hospital clinic, an ambulatory surgery center, or a freestanding diagnostic center, the facility prepares its own bill. Facility payments may also be estimated using Medicare payment methods. In the past, Medicare paid facilities their cost-adjusted charges, and there was no schedule of facility reimbursements associated with different procedures. Medicare adopted a prospective payment system for facility fees in 2000 (U.S. Department of Health and Human Services 2000). Medicare now pays facilities according to the ambulatory payment category assigned to the procedure.

The pseudo-bill represents an estimate of charges or reimbursement. It is not the economic cost of providing the service. Health care providers usually set charges to be higher than their costs, hoping to earn revenues that can be used to subsidize uninsured patients or provide profit to shareholders. Reimbursements, which are usually less than charges, are not necessarily equal to

the cost of providing care; they do represent costs from the perspective of the payer. Analysts may want to adjust the pseudo-bill to reflect actual economic costs. One way for VA investigators to do this is to find all ambulatory charges at a medical center and adjust them so that they are equal to the total ambulatory costs reported in the VA department-level cost report, CDR.

**Inpatient Pseudo-Bills**

The large number of services provided in a hospital stay makes it much more difficult to prepare a pseudo-bill for this care. It would be very expensive for a VA investigator to do this, as VA does not gather the same level of detail on the resources used in a hospital stay that is needed for an itemized bill.

A simpler alternative is to estimate the Medicare reimbursement under the rules of the prospective payment system. Medicare pays hospitals based on the diagnosis related group (DRG) associated with the stay. Each DRG is assigned a relative weight, and the weight is multiplied by a factor to arrive at the reimbursement. Further adjustments are made for costs of medical education, capital, uninsured patients, and very lengthy stays. Cost estimates based on DRG weights have been used for VA studies, including evaluation of the cost effectiveness of cholesterol-lowering drugs (Nyman et al. 2002).

Estimates of the cost of acute medical surgical stays based on DRG weights capture more of the variation in resource use than estimates that are based on length of stay (Barnett 1997). DRG weight cost estimates may not be sensitive to all of the effects of an intervention on hospital costs, however. Resource use may vary in ways not captured by the DRG assignment; for example, the patient may have a longer or more complex stay than is typical for that DRG, or the study may be evaluating an intervention that increases cost without changing the DRG.

Preparation of a pseudo-bill for physician services to hospitalized patients is challenging in the VA environment, as physician services to inpatients are incompletely recorded in VA databases. Inpatient physician care is characterized in VA databases with the International Classification of Diseases (ICD)–9 codes. Physicians who practice in non-VA hospitals use CPT codes to bill for their services. Medicare and other payers do not have schedules of the physician reimbursement associated with ICD-9 procedure codes, which are less specific than CPT codes. VA hospital discharge data include codes for surgeries but often exclude medical procedures, including invasive procedures performed by cardiologists, pulmonologists, and gastroenterologists. The data also exclude physician consultations and daily visits. To prepare a pseudo-bill requires that the analyst directly record physician activity.

**Summary**

The pseudo-bill method provides a useful method of estimating the cost of ambulatory care. Medicare reimbursement rates are easily accessed and can be used to estimate costs. The drawback of this method is the complexity of Medicare payment methods. Medicare does not cover many services provided by VA. Reimbursement rates for some services must be obtained from other payers. To be used as an estimate of the cost of care, the reimbursement needs to be adjusted to reflect actual VA costs. Estimation of the cost of VA outpatient visits has been systematically undertaken by the VA HERC, and the results are described below and in more detail by Phibbs et al. (2003 [this issue]).

VA does not gather the data needed to prepare detailed inpatient pseudo-bills. Medicare reimbursement rates can be used to estimate hospitals costs, but these estimates do not fully capture the variation in resource use in hospital stays. Analysts who need more accurate information on hospital cost should consider using the cost regression method.

## COST REGRESSION

The third cost determination method considered in this article, cost regression, is a useful way to estimate the cost of hospital stays. A regression is estimated using data from non-VA hospital stays. The dependent variable is cost-adjusted charges. The independent variables are the characteristics of the stay, such as diagnosis and length of stay. The regression model parameters are then applied to VA utilization data to simulate the cost-adjusted charges of VA stays. Cost regressions have been used to estimate the cost of hospital stays of patients with leukemia (Welch and Larson 1989) and the cost of VA stays for acute myocardial infarction (Barnett et al. 2002). Since this method uses the limited number of characteristics of hospital stays that explain most of the variation in their cost, it requires much less detailed data than creation of an inpatient pseudo-bill.

The cost regression method requires data on non-VA patients with comparable conditions. Such data may be available from hospital discharge data sets. If a suitable data source can be found, this method represents a relatively economical means of estimating VA hospital costs. The approach requires the assumption that the pattern of resource use in the non-VA sample is the same as in the VA sample. Explanatory variables are limited to those that occur in both the VA and non-VA data sets. The choice of model can have a substantial impact on the predicted cost (Andersen, Andersen, and Kragh-Sorensen 2000).

Cost regressions are ordinarily estimated from cost-adjusted charges reported in hospital discharge data. These data sets exclude physician services, as physicians bill payers separately. Although it would be possible to estimate a separate cost regression for physician services, it is difficult to access physician claims and associate them with a particular hospital stay.

One approach is to simply assume the physician services are proportionate to the hospital bill. The average cost of physician services for inpatient care can be expressed as a percentage of the hospital bill and added to the estimate of the hospital cost.

An alternative method is to use data on the average payment for physician services found in other studies. Two studies have examined the average Medicare reimbursement for physician services provided to hospitalized patients for each DRG (Mitchell et al. 1995; Miller and Welch 1993). Such estimates need to be adjusted for inflation. They may also need to be adjusted to reflect physician costs that differ from the average for that DRG. For example, VA hospital stays are longer than Medicare stays. This requires additional days of physician service.

Cost regression is a practical method of estimating the cost of hospital stays. The analyst must find a comparable non-VA data set, model the relationship between cost and the characteristics of the stay, combine the model with VA data to estimate predicted cost, and then adjust the result to reflect total VA expenditures. HERC has used this method to estimate the cost of VA stays for acute medical-surgical care, as described in the following section of this article and in more detail by Wagner, Chen, and Barnett (2003 [this issue]).

Cost estimates based on regression models do not capture all of the variation in the resources used in hospital stays. The analyst must also decide whether it is appropriate to adopt the assumptions used to employ the cost regression method. Since there is no easily accessed source of physician reimbursements associated with hospital stays, available cost regression studies of the physician component of inpatient stays are now quite dated.

## HERC AVERAGE COST DATA SETS

One of the two VA data sources with the cost of individual VA health care encounters was created by HERC. The cost estimates are based on the costs reported in CDR, utilization from the PTF and outpatient care file, and non-VA data on the relative costs of health care encounters. Estimates of the cost of acute medical and surgical inpatient stays were constructed using a cost regression. Estimates of the cost of ambulatory care were constructed using the pseudo-bill method.

The HERC cost estimates rely on the assumptions that VA providers use the same relative quantity of resources as non-VA providers and that encounters with the same characteristics have the same relative cost. HERC has created files of all care that has occurred since 1 October 1997; methods for earlier years have been described, but comprehensive estimates have not been prepared (Barnett, Chen, and Wagner 2000; Barnett 1997).

The methods used to prepare these estimates are described in other articles in this issue. The cost of acute medical and surgical care was estimated using measures of relative value estimated from a cost regression estimated from veterans' stays in Medicare hospitals (Wagner, Chen, and Barnett 2003). The cost of long-term care was based on estimates of the relative resource use associated with case mix measures from periodic assessment of VA long-term care patients (Yu et al. 2003). The cost of outpatient visits was estimated using the payments from Medicare and other payers as a measure of relative value (Phibbs et al. 2003). The HERC outpatient cost data set does not include the cost of prescription drugs. These costs may be obtained from VA prescription databases described in another article in this issue (Smith and Joseph 2003 [this issue]).

The HERC average cost data sets are available to researchers who obtain permission to access data in the national VA computer center. HERC has estimated the cost of each health care encounter using the national average cost of similar encounters. It has also provided a local cost estimate, reflecting expenditures reported for that facility in CDR. These estimates might be useful to researchers interested in determining the economic consequences of an intervention using the cost of a specific medical center. Because of the vagaries of CDR, these local cost estimates are less reliable than the national estimates. For medical-surgical stays and outpatient visits, the HERC files also contain an estimate of the cost of the care had it been provided in the non-VA setting.

Analysts need to be aware of the limitations of the HERC data sets that stem from the assumptions needed to create them. The HERC data sets were created by assuming that the relative cost of hospital care in VA is the same as in Medicare hospitals and that the relative cost of outpatient care is the same as in the Medicare reimbursement schedules. The data sets were named the "average cost" data sets because they are based on the assumption that every encounter has the average cost of all encounters identified by the same characteristics in the utilization databases. For this reason, these data sets cannot be used to study the efficiency of a particular health care provider, for example, to learn if a particular medical center has lower than average cost in caring for patients in a certain DRG. The average cost data sets may not be useful for evaluating the impact of an intervention that might change the cost of a

hospital stay or an outpatient visit. The analyst should use direct measurement to estimate these types of impacts.

## DSS

The second data source with the cost of VA health care encounters is DSS. VA has implemented this activity-based costing system to determine the cost of VA departments, intermediate health care products, hospital stays, and outpatient encounters. It was implemented throughout VA health care systems by 1 October 1998, but at the time this article was written, systemwide standardization had not been achieved. DSS data have been used to study treatment for heart attack (Barnett et al. 2002) and the consequences of complications of warfarin therapy (Hamby, Weeks, and Malikowski 2000).

DSS extracts costs from the VA payroll and general ledger. Costs are assigned to departments based on periodic reports from physician staff and managers. Six categories of labor and supply expense are distributed. Overhead (the cost of departments that do not produce patient care) is distributed to patient care departments using a step-down allocation method. Direct cost or the number of square feet of occupied space is used as the basis of the allocation.

Costs of intermediate products are then determined. Examples of intermediate products are a chest X ray, a unit of blood, a 15-minute clinic visit, or a day of stay in the intensive care unit. They are called intermediate products to distinguish them from the final product, a patient encounter, which is a bundle of intermediate products.

DSS relies on VISTA, the system of VA electronic medical records, for information on intermediate products provided. Relative value units (RVUs) are assigned to each product based on an estimate of the relative costs of the resources needed to produce it. The department's cost per RVU is calculated and multiplied by the RVUs assigned to the intermediate product to determine its cost.

In a final step, intermediate products are associated with stays and outpatient visits to determine encounter-level cost. The encounter-level cost can be found in national extract files. These extracts report the cost of individual VA hospital stays, the total cost of care received from a single outpatient clinic received by each patient on a single day, and the total outpatient pharmacy cost incurred by each patient in a single day. Although data are available beginning with the 1998 fiscal year, early years are especially unreliable. These files have been described elsewhere along with preliminary validity tests (Yu and Barnett 2002). A national extract file has also been created with the department-level costs of each medical center.

The cost and quantity of intermediate products used in each health care encounter are not found in the national files. These data are decentralized in the DSS production system, making them considerably more difficult to access.

DSS has the potential of providing cost estimates that are far more accurate than methods currently used in VA cost-effectiveness studies. Indeed, if the system is properly implemented, the cost estimates should be more sensitive to variation in resource use than the cost-adjusted charges used in non-VA cost-effectiveness studies. Analysts will still need to use direct measurement to evaluate the cost of most new interventions.

There are several concerns about the accuracy of DSS (Barnett 1999). DSS has been implemented relatively recently by VA. It is not known if facilities accurately distribute staff costs among departments or estimate the relative effort required to produce different health care products. Because VA physicians do not bill for their services, they do not have the same incentive that non-VA physicians have to document their work; VA databases do not reflect the same level of detail found in non-VA physician claims databases, which list billable services. For example, some VA sites do not record cardiac catheterization procedures in a way that allows DSS to determine their cost (Barnett 1999). At the present writing, DSS data have not been sufficiently validated for research proposals to rely exclusively on this source.

## DISCUSSION: WHICH METHOD TO EMPLOY?

The choice of cost determination method depends on the goals of the study, its time frame, and its perspective. The choice invariably involves a trade-off between accuracy and the resources available to conduct the study. All of the methods have their appropriate use, depending on the study hypothesis. A mix of methods is needed for many studies.

The advantages and disadvantages of the methods described in this article are listed in Table 1. Direct measurement is an accurate method of finding the cost for care that is innovative or otherwise unique to VA. It is too labor intensive to be used for all health care; other methods must be used to find the overhead cost associated with hospital-based programs and the cost of other types of health care obtained by study participants.

Direct measurement is needed by analysts examining provider efficiency, for example, in a study of whether a particular medical center has higher than expected costs of providing hospital stays for a specific DRG. The HERC average cost estimates cannot be used for this purpose, as they are created with the assumption that all hospitals use the same relative quantity of resources to provide a stay with a given DRG. Cost estimates from DSS may prove useful in

TABLE 1 Comparison of VA Cost Determination Methods

| *Method* | *Source of Data* | *Assumption* | *Advantage* | *Disadvantage* |
|---|---|---|---|---|
| Direct measurement | Staff activity analysis; payroll data on labor cost; estimate of supply costs | May assume all utilization uses the same amount of resources | Useful to determine cost of a program that is unique to VA | Limited to small number of programs; cannot find indirect costs; cannot find total health care cost |
| Itemized list costing (pseudo-bill) | Detailed utilization data; schedule of charges adjusted for cost | Schedule of charges reflects relative resource use; cost-adjusted charges reflect VA costs | Captures effect of intervention on pattern of care within an encounter | Expense of obtaining detailed utilization data; charge schedule may not represent VA costs; difficulty of preparing inpatient pseudo-bill |
| Cost regression based on non-VA data | Previous study with cost-adjusted charges and detailed utilization; reduced list of utilization measures previously identified as important | Same as for pseudo-bill; the relation between cost and utilization is the same in the current study as in the previous study | Less effort to obtain reduced list of utilization measures than to prepare pseudo-bill | Must have detailed data from prior study; may result in error or bias |
| HERC average cost of acute medical and surgical stays method | CDR matched to patient treatment file; relative values from analysis of cost of veterans' Medicare stays | VA use of resources for different diagnoses and lengths of stay same as for non-VA hospitals | Avoids bias of assuming all days of equal cost; can estimate cost from administrative data | Only appropriate for acute medical and surgical stays; not sensitive to all sources of variation in resource use cost |

TABLE 1 (continued)

| *Method* | *Source of Data* | *Assumption* | *Advantage* | *Disadvantage* |
|---|---|---|---|---|
| HERC average cost of long-term care method | CDR matched to patient treatment file and patient assessment file | Cost of long-term care days is proportionate to weighted work units assigned in long-term care patient assessment | Captures variation associated with resource case mix intensity of long-term care patients | Method has greater complexity; relies on patient assessment data and assumptions about resource used to care for patients in each assessment category |
| HERC outpatient average cost method: charges based on CPT codes adjusted for costs in CDR | CDR matched to outpatient care file | All visits with the same CPT codes have the same cost | Can estimate cost from administrative data | Assumes that VA characterizes care with appropriate CPT codes and that non-VA charge schedules represent VA relative cost of production |
| DSS | DSS national extract or DSS production data | Accurately assigns costs; finds relative value units; identifies utilization | Staff at each facility develop estimates of cost of department, products, and encounters | Needs to be validated; some known problems |

Note: VA = U.S. Department of Veterans Affairs; HERC = Health Economics Resource Center; CDR = Cost Distribution Report; CPT = current procedures and terminology; DSS = Decision Support System.

this type of study, but the analyst must be aware of one important deficiency at many DSS sites: the lack of data on nonsurgical procedures.

Evaluations of the short-run consequences of managerial decisions also require direct measurement of costs. The short-run perspective ignores costs that are fixed, such as capital costs and many labor costs. Direct measurement is needed to distinguish fixed costs from those that are variable in the short term. In the short run, the incremental cost is less than average cost. The DSS may prove useful for this type of research, as it distinguishes fixed from variable cost. The distinction between fixed and variable cost made in DSS may

not be appropriate for all studies that need an estimate of short-run incremental costs, however.

When studying the cost effectiveness of new health care interventions, direct measurement is often needed to assess the cost of the intervention itself. The assumptions used to create pseudo-bills and cost regressions preclude their use for this purpose. It is also unlikely that DSS cost estimates will reflect the impact of innovation on cost.

Simpler methods can be used to find the cost of other care obtained by study participants. The pseudo-bill method can be used to find the cost of ambulatory care. The pseudo-bill method assumes that the Medicare reimbursement schedule reflects the relative cost of different services and that VA resource use is proportionate to the Medicare reimbursement rates. The analyst may wish to adjust the pseudo-bill by a constant so that the resulting cost estimate is equal to the provider's long-run incremental cost. VA does not gather data needed to prepare inpatient pseudo-bills.

Cost regressions can be used to find the cost of inpatient care. The cost regression method assumes that the relationship between costs and characteristics of hospital stays is the same in VA as in non-VA hospitals. This method does not capture all of the variation in resource use in hospital stays.

HERC has created comprehensive data sets with estimates of the cost of all VA care provided since 1 October 1997. Outpatient costs were estimated with a pseudo-bill. The costs of acute medical-surgical hospital stays were estimated with a cost regression. These estimates were adjusted to reflect VA costs as reported in CDR. They do not capture the full cost of VA capital or malpractice expense, as these are not completely reported in CDR.

The HERC cost estimates are called the average cost data sets because all encounters with the same characteristics are assigned their average cost. They are a useful source of data on the costs incurred by populations of patients, for example, in a study of how annual health care costs vary with patient case mix. These cost estimates may not fully reflect how an intervention affects resource use or how provider efficiencies differ from the mean.

VA has implemented DSS, an activity-based costing system. The national encounter-level cost databases from this system promise to be highly useful for researchers as known problems are resolved. As DSS becomes more accurate, it will become the standard source of follow-up costs and population-based costing.

Analysts conducting cost studies are frequently confronted with less than perfect data. When accuracy is uncertain, data should be validated from an independent source. All assumptions should be articulated. The analyst may need to use alternate utilization data and alternative cost-finding methods

and conduct sensitivity analyses to determine if findings are affected by the data sources or analytic assumptions.

## DISCUSSION: PLANS FOR IMPROVEMENT

The accuracy of VA cost estimates will improve as current deficiencies in centralized VA databases are understood and corrected. VA inpatient files do not completely record physician services; medical procedures may be excluded; daily visits and consultations are not recorded at all. VA is developing new software to record physician services to inpatients.

VA outpatient files may understate laboratory tests and prosthetic supplies. Software limitations exclude a small percentage of procedures from the national outpatient data sets. HERC is working with the Veterans Health Administration to evaluate the codes used to characterize outpatient care. HERC is evaluating whether estimates of the cost of prosthetics can be improved by using data from the VA national prosthetics database. Contract providers render an increasing share of VA care; HERC is documenting the VA contract care databases. HERC is also working to improve surveys used to assess patient incurred cost and instruments used to ask patients to report the cost of care they receive from non-VA providers.

The methods used to create CDR are far from adequate, and some medical centers are known to have suspect data. This limits the usefulness of data that depend on CDR, including the HERC average cost data sets. The local cost estimates in the HERC file are especially affected by this concern. The solution to this problem is the replacement of CDR by DSS data. A new national DSS department-level extract may supplant the use of CDR in the near future.

The DSS national extracts exclude some care; some sites have biased data, and others have estimates that are clearly in error. HERC is conducting validation studies of DSS and working with the national DSS program office to identify ways in which DSS data can be improved. HERC also plans systematic comparison of the HERC average cost data set to the DSS national extracts.

Plans to improve the quality of VA data are part of a larger effort to improve the completeness and accuracy of VA health care cost estimates. The goal of this effort is to improve the quality of VA health economics research and to make it easier to undertake.

Most health care interventions have been adopted with little information about their economic consequences or their cost effectiveness. Additional cost-effectiveness research will provide information needed by medical decision makers and ensure that the best possible use is made of finite health care resources.

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# Methods for Patient-Level Costing in the VA System: Are They Applicable to Canada?

*Gordon Blackhouse*
*Ron Goeree*
*Bernie J. O'Brien*
McMaster University and St. Joseph's Hospital

In his article "Determination of VA Health Care Costs," Barnett (2003 [this issue]) describes various methods available to estimate costs in the U.S. Veterans Affairs (VA) health care system. These methods include direct measurement, pseudo bills combining VA patient-level utilization data and non-VA cost lists, cost functions based on regression analysis using non-VA cost estimates, and average cost databases. The need for these methods arises from the fact that VA hospitals do not prepare patient bills, the primary source of health care costs used in U.S. health economic studies.

Barnett (2003) suggests that the principles of cost determination described in his article can be applied to other settings where billing data are not available. This is the case in Canada, where acute-care hospitals are publicly funded through global operating budgets. Because very few hospitals have information systems that produce reliable patient-level costing data, Canadian health economists rely on similar cost-estimation methods to those detailed by Barnett. The parallels between VA health care costing methods and those used by Canadian investigators are detailed in the remainder of this commentary.

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## THE DECISION SUPPORT SYSTEM (DSS)

The Health Economics Resource Center (HERC) average cost database and the DSS are attempts to overcome the absence of billing records in the VA health care system. Both produce estimates of costs for all individual inpatient admissions; however, the estimation techniques are different. The HERC database estimates rely on cost functions based on non-VA hospital cost data, while the DSS employs a top-down fully allocated costing technique based on VA hospital cost and utilization data. In Canada, a similar effort has been made by two provincial hospital costing initiatives: the Ontario Case Costing Initiative (OCCI) (Ontario Hospital Association and Ontario Ministry of Health OCCPJP & PC 1999) and the Alberta Costing Partnership (ACP) (Health Resourcing Branch 2002). In both cases, selected hospitals (6 in Alberta and 21 in Ontario) produce cost estimates for individual inpatient encounters using techniques similar to the VA DSS. Inpatient cost estimates are based on standardized fully allocated costing methods. At the time of publication, both ACP and OCCI had available data based on fiscal year 2000-2001.

The usefulness of these cost data in prospective economic evaluations is somewhat limited compared to the HERC and DSS databases. Potentially, cost records from the HERC database and DSS can be extracted to directly cost all hospitalizations for patients participating in VA economic trials. However, the proportion of Canadian hospitals involved in the OCCI or ACP is small. Therefore, it is unlikely that hospital cost records would be available for all hospitalizations for patients participating in a Canadian prospective economic evaluation. Despite this limitation, OCCI and ACP data have proven to be among the best source of costing data in Canada. Both have publicly available data on the average length of stay and average cost per hospitalization according to diagnosis. Data from individual hospitals participating in the provincial costing initiatives are useful in other costing approaches.

## PSEUDO BILLS

Pseudo bills are another approach suggested to estimate health care costs in the VA health care system. In this method, itemized lists of health care resources are combined with reimbursement or charge schedules to estimate the cost of an encounter. For Canadian researchers, cost data from individual hospitals participating in provincial costing initiatives can be used in place of the reimbursement schedules suggested by Barnett (2003). Part of the process of producing patient-level costs in ACP and OCCI is assigning costs to

intermediate products such as diagnostic tests, surgical procedures, and daily costs in specific types of wards. These costs can then be combined with health care utilization data collected in prospective clinical trials to create a type of pseudo bill estimate.

Barnett (2003) also suggests creating pseudo bills for inpatient stays by estimating the Medicare reimbursement for the stay. This can be accomplished by multiplying the relevant diagnosis related group weight used in the prospective payment system by a cost factor. The Institute for Health Economics in their publication *A National List of Provincial Costs for Health Care: Canada 1997/98* (Jacobs et al. 2000) suggested a similar method for estimating inpatient costs. In what they called the cost per weighted case approach, a standard cost of a hospitalization related to a specific case mix group (CMG) in a particular province can be derived by multiplying the resource intensity weight (RIW) of the CMG by the average cost per weighted case in the province of interest. The standard cost per weighted case by province is provided in the publication. The RIW of specific CMGs can be obtained from the Discharge Abstract Database produced by the Canadian Institute for Health Information (1994). CMGs and their respective RIWs are subcategorized by age and complexity level.

## COST PREDICTION MODELS

Cost prediction models (Willan and O'Brien 2001) are also suggested as a method to derive estimates of VA inpatient costs. In this approach, coefficients from a regression equation using data from non-VA hospitals are combined with VA utilization data to create inpatient cost estimates. The cost and utilization data provided by participating OCCI and ACP hospitals can be used to create similar cost prediction estimates for Canadian inpatients.

This approach was used by O'Brien et al. (2000) in an economic evaluation of Canadian participants from a clinical trial of hospitalized patients randomized to either regular heparin or molecular weight heparin. Use of selected health care resources during hospitalizations was collected prospectively during the trial. Records for 1,044 hospitalizations from a participating OCCI hospital with admitting diagnosis identical to those of patients entering the trial (unstable angina, non-Q-wave angina) were used to create a multivariable regression model. Total costs were used as the dependent variable, while resource utilization variables identical to those collected in the trial were used as independent variables. The coefficients of the cost function were combined with the utilization data collected for individual patients in the trial to estimate inpatient costs.

## CONCLUSION

The Canadian health care system is characterized by public funding, and this single-payer system has resulted in hospitals being funded by global budgets. The downside of this system for the health economist conducting cost-effectiveness studies is that patient-specific billing and/or cost data are not readily available. The VA system in the United States faces similar problems and has been innovative in developing several approaches to patient-level costing that can be generalized, in different ways, to the Canadian setting.

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# Prevalence and Costs of Chronic Conditions in the VA Health Care System

*Wei Yu*
VA HSR&D Health Economics Resource Center;
Center for Health Policy and Center for Primary Care
and Outcomes Research, Stanford University
*Arliene Ravelo*
Department of Global Health Outcomes
Strategy & Research, Allergan Inc.
*Todd H. Wagner*
VA HSR&D Health Economics Resource Center;
Center for Health Policy and Center for Primary Care
and Outcomes Research, Stanford University;
Health Research and Policy Department at Stanford University
*Ciaran S. Phibbs*
VA HSR&D Health Economics Resource Center;
Center for Health Policy and Center for Primary Care
and Outcomes Research, Stanford University;
Health Research and Policy Department at Stanford University
*Aman Bhandari*
University of California at Berkeley
*Shuo Chen*
VA HSR&D Health Economics Resource Center
*Paul G. Barnett*
VA HSR&D Health Economics Resource Center;
Center for Health Policy and Center for Primary Care
and Outcomes Research, Stanford University;
Health Research and Policy Department at Stanford University

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*Chronic conditions are among the most common causes of death and disability in the United States. Patients with such conditions receive disproportionate amounts of health care services and therefore cost more per capita than the average patient. This study assesses the prevalence among the Department of Veterans Affairs (VA) health care users and VA expenditures (costs) of 29 common chronic conditions. The authors used regression to identify the marginal impact of these conditions on total, inpatient, outpatient, and pharmacy costs. Excluding costs of contracted medical services at non-VA facilities, total VA health care expenditures in fiscal year 1999 (FY1999) were $14.3 billion. Among the 3.4 million VA patients in FY1999, 72 percent had 1 or more of the 29 chronic conditions, and these patients accounted for 96 percent of the total costs ($13.7 billion). In addition, 35 percent (1.2 million) of VA health care users had 3 or more of the 29 chronic conditions. These individuals accounted for 73 percent of the total cost. Overall, VA health care users have more chronic diseases than the general population.*

***Keywords:*** *cost; economic; chronic disease; veterans; mental health*

Rising health care costs and limited financial resources have motivated health care providers to better understand the patient populations they serve and the costs associated with the medical services they provide. Chronic conditions are among the largest causes of death and disability in the United States (Murray and Lopez 1996) and therefore account for disproportionate health care utilization and cost (Hoffman, Rice, and Sung 1996). Consequently, such conditions have become the focus of study for health systems desiring a more cost-efficient and cost-effective way to provide medical care to their patients.

Previous research into the prevalence and cost of chronic diseases is usually focused on individual conditions. Several cost estimates have been reported for individual chronic conditions, such as diabetes (American Diabetes Association 1998; Amin et al. 1999; Gilmer et al. 1997; Leese 1992; Selby et al. 1997; Simell et al. 1996), chronic obstructive pulmonary disease (COPD) (Strassels 1999; Strauss et al. 1986; Strassels et al. 2001; Ruchlin and Dasbach 2001; Mapel et al. 2000; Friedman and Hilleman 2001), hypertension (Jacobs 1998; Stason 1989), heart disease (Guico-Pabia et al. 2001; Wittels, Hay, and Gotto 1990), cancer (Leake 1995; Taplin et al. 1995), depression (Simon, VonKorff, and Barlow 1995), and Alzheimer's disease (Weiner et al. 1998).

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Few studies have provided systematic cost estimates for a number of common chronic conditions on a large patient population within an integrated health care system. Group Health Cooperative of Puget Sound and Kaiser Permanente are two staff-model managed care organizations that have each estimated the annual costs of a select set of chronic diseases for their system (Fishman et al. 1997; Ray et al. 2000). These previous studies are limited by the fact that most Group Health Cooperative and Kaiser Permanente enrollees are employed or covered by Medicare. Hence, results from these studies lack information on services that are not covered by private insurance or Medicare (e.g., long-term care). In addition, enrollees have different benefit packages and face different copayments. These differences affect the demand for services and subsequently the relative cost of care for the disease category. Unlike Group Health Cooperative and Kaiser Permanente enrollees, veterans who enroll in the Veterans Health Administration (VA) have a uniform set of health care financing benefits. While it provides medical-surgical and outpatient care, which is similar to Group Health Cooperative and Kaiser Permanente, the VA also offers many other services, including specialized mental health, long-term care, rehabilitation, domiciliary care, and pharmacy benefits. For many of these services, VA is the largest provider in the nation. Therefore, assessing the cost of chronic conditions in the VA provides unique insights into how these conditions affect overall health care costs.

## NEW CONTRIBUTION

The VA operates one of the largest integrated health care systems in the United States, providing health care services to more than 3 million veterans in fiscal year (FY) 1999. In addition to having a unique patient population, VA offers more comprehensive health care benefits than Medicare, many managed care plans, or other private health insurance programs. Prescription drug benefits, long-term care, and special programs for substance abuse and mental health are some of these additional VA medical benefits. This study provides the first systematic and comprehensive analysis on prevalence of and expenditures for chronic conditions in the VA. The findings provided by our study should be useful in informing policy makers and providers about resource utilization of patients with chronic diseases, in determining budget allocations to adequately meet projected future costs, and in setting priorities for areas most in need of further research.

## METHOD

### DATA

This study used data from the VA Patient Treatment File (PTF) and Outpatient Event File (SE) for FY1999, the most recently available files at the time the analysis was conducted (Murphy et al. 2002; Hynes, Joseph, and Pfeil 2002). PTF recorded all inpatient care provided by the VA Health Care System, including acute and long-term hospitalizations, nursing home stays, and residential programs. The Events File contained every encounter to a VA clinic, including primary care and specialty clinics. To calculate the prevalence and unadjusted costs of selected chronic conditions, we included every person recorded in these two files ($N$ = 3,408,760).

Because of the large sample size, we randomly selected a 20 percent sample of this population for a multivariate analysis on costs attributable to each chronic condition. The subsample was identified using the RANUNI function in SAS. Since new patients may have partial health care utilization during the year, we excluded patients who were not in the VA system in the previous year (81,770). The final sample for regression analysis has 599,975 patients. We compared the prevalence and average costs per disease of the regression sample with the study population. We obtained race/ethnicity, marital status, military service–related disability, and low-income eligibility from the outpatient event file, and patient mortality within FY1999 from the VA's Beneficiary Information and Records Locator Subsystem (BIRLS). The BIRLS file is updated daily in real time.

### SELECTION OF CHRONIC CONDITIONS

We selected 29 common chronic conditions based on prior studies (Ray et al. 2000; Fishman et al. 1997), designated research areas for VA (Office of Research and Development 1998), and VA quality enhancement programs (the QUERI initiative; Demakis et al. 2000). Because VA is a major provider of mental health and substance abuse care, we further divided these into eight and five categories, respectively (see Table 1 for complete listing of 29 conditions plus subcategories).

### CHRONIC DISEASE IDENTIFICATION AND CLASSIFICATION

We identified patients with the chosen chronic conditions using ICD-9 diagnoses recorded in the inpatient PTF and outpatient event files in FY1999. Both files contain up to 10 ICD-9 diagnostic codes for each admission or

TABLE 1 Number of Chronic Conditions among Veterans Affairs (VA) Patients

| *Number of Conditions* | *Persons with Condition* | *% of Total Population* | *Mean Age* | *Average Total Cost ($) per Person* | *% of Total Costs to VA System* |
|---|---|---|---|---|---|
| No conditions | 958,921 | 28 | 51 | 648 | 4 |
| 1 or more conditions | 2,449,839 | 72 | 60 | 5,833 | 96 |
| 1 condition | 678,512 | 20 | 57 | 1,995 | 9 |
| 2 conditions | 591,599 | 17 | 61 | 3,366 | 13 |
| 3 or more conditions | 1,179,728 | 35 | 62 | 9,277 | 73 |

encounter. We reviewed the classification methods from the Kaiser Permanente (KP) study (Ray et al. 2000) and other published studies (Peterson et al. 1994; Deyo, Cherkin, and Ciol 1992). We compared these classification methods with the Clinical Classifications Software (CCS) developed by the Agency for Healthcare Research and Quality (2000). CCS, a classification system developed by a panel of physicians, allocates all ICD-9 codes into broad medical conditions. Because the CCS has to exhaust all ICD-9 codes, some codes that do not clearly identify a disease have to be classified into a broad group. Therefore, the classification methods used by KP and other studies are generally more conservative in disease classification than CCS.

When selecting ICD-9 codes to identify a disease, we conducted a sensitivity analysis when the classification methods differ between the CCS and the published studies. In general, CCS has more inclusive criteria than KP and published VA studies. For most of the 29 conditions in our study, using CCS increased the number of patients by approximately 1 percent or less. In these cases, we chose to be conservative and to follow the KP system along with the published VA literature. For the medical conditions where CCS had a discrepancy of 1 percent or larger from the other methods, physicians reviewed these codes. Diagnostic codes that did not clearly specify a chronic condition were excluded. For example, CCS includes ICD-9 code 490 (bronchitis) in COPD. However, code 490 does not distinguish between acute or chronic. In contrast, the KP classification system excluded code 490 from COPD for this reason. Thus, for COPD, we followed the more conservative classification method.

We used all of the diagnostic codes in the inpatient and outpatient files to identify patients with each chronic condition. For most conditions, we used a single diagnosis to classify a patient. Patients with both asthma and COPD diagnoses were classified as asthma only. For depression, we required two or more outpatient diagnoses or a single diagnosis from a psychiatric clinic.

Thus, all VA patients using care during FY1999 were associated with chronic conditions that were coded during one or more inpatient stays or outpatient encounters. The diagnoses and specific codes used to identify each condition are available on request from the authors.

## DETERMINATION OF MEDICAL CARE COST

We estimated annual costs of medical care incurred by VA for FY1999 (1 October 1998 through 30 September 1999). The costs were grouped for inpatient, outpatient, and outpatient pharmacy services. Inpatient care included medical/surgical stays, rehabilitation, specialty mental health, and long-term hospitalizations (i.e., intermediate medicine, domiciliary, and nursing home care). Outpatient care included all health care services provided at VA outpatient clinics. For inpatient stays that spanned fiscal years (i.e., stays with admission dates before 1 October 1998 or discharge dates after 30 September 1999), we allocated total inpatient cost proportional to the number of days that occurred within FY1999. All estimated expenditures were in 1999 dollars.

Inpatient and outpatient costs were obtained from the average cost database developed by the VA Health Economics Resource Center (HERC). For medical and surgical hospitalizations, costs were allocated to each hospital stay using a relative weight developed from a cost regression based on Medicare's Diagnostic Related Group (DRG) relative value weight and length of stay (Wagner, Chen, and Barnett 2003). Nursing home costs were adjusted for acuity by the Resource Utilization Group (RUG) II measure (Yu et al. 2003). For inpatient rehabilitation and mental health care, a simple per diem cost was calculated (Yu et al. 2003). Outpatient health care costs were based on the Current Procedural Terminology (CPT) codes recorded in the database. HERC developed relative weights for all the CPT codes recorded in the VA database (Phibbs et al. 2003). The relative weights were primarily based on: Medicare Resource Based Relative Value Unit (RVRBS) (Hsiao et al. 1992), Relative Value Units developed by the Ingenix Corporation (2000), the 1999 survey of the American Dental Association (2000), Wasserman's (2000) dental fee schedule, and the payments allowed by the California Workmen's Compensation System (State of California 1999). These relative weights were used to allocate VA outpatient costs to each encounter (Wagner, Chen, and Barnett 2003; Phibbs et al. 2003; Yu et al. 2003).

Costs for outpatient pharmacy were obtained from the 1999 VA Decision Support System (DSS) national extract. DSS extracted costs from the VA accounting system and allocated them to direct service departments (e.g., outpatient pharmacy clinic). Overhead costs were distributed to each direct service department. The overhead costs were further allocated to department

products based on volume and on relative value units in resource use (Yu et al. 2003). Because FY1999 was the 1st year for the DSS pharmacy national extract, we observed unrealistic outliers caused by errors in data entry (e.g., using gram for milligram). We also found that most of the outliers were in three facilities. Therefore, we replaced outpatient pharmacy costs for patients in these three facilities by national averages. Because the rest of the outliers accounted for only 0.1 percent of the total records, we included them in the calculation of average costs for the entire population. Such outliers can significantly affect regression coefficients, however. Consequently, we used the Winsorizing transformation for the regression sample. This transformation replaces the extremes by the next value counting inwards from the extremes (Barnett and Lewis 1994). We Winsorized 0.1 percent, approximately 600 of the most expensive records, of the outpatient pharmacy data in the sample.

We calculated average annual costs per person for all 3.4 million patients whether they had any of the 29 chronic conditions. Because a person could have multiple chronic conditions, the 29 groups are not mutually exclusive. Therefore, the sum of costs of the 29 conditions do not equal the total costs for people with the 29 conditions. The unadjusted costs for each chronic condition group also included costs of health care for other medical conditions. In addition to total annual cost per person, we examined inpatient medical/surgical, other inpatient, outpatient, and outpatient pharmacy costs for people with each of the 29 chronic conditions. We summarized costs for patients with zero, 1, 2, and 3 or more chronic conditions. These findings are displayed in Table 1 and discussed below.

For those who died during the year, we reported actual costs. On average, decedents had 6 months of health care use. We did not adjust their costs to 12 months for two major reasons. First, health care costs accelerate rapidly during the final months of life (Garber, MaCurdy, and McClellan 1998). Expanding these costs to 12 months would substantially overestimate annual costs. Second, for a population, reporting actual annual costs for each disease reflects the fact that some patients die during any year. Although adjusting costs for partial use of health care during the year might be more accurate at the patient level, the adjusted average cost of a disease for a population would always overestimate actual average costs of the population in any year.

## REGRESSION ANALYSIS

Using a 20 percent random sample of the patients ($n$ = 599,975), we regressed total annual costs on patient descriptors of: age, gender, race, service-related disability, low-income eligibility, and the 29 chronic conditions. Interactions between age and chronic conditions were also included in

the regression. We used age as a continuous variable in the final model because the relationship between age and costs was approximately linear in preliminary analyses. Other independent variables were treated as dichotomous. All independent variables were expressed as deviations from their respective means so that the constant term was equal to the sample means. Substituting independent variables with their deviations from the mean, however, would not change the value of the estimated coefficients in the regression. In addition to examining total costs, we assessed inpatient, outpatient, and outpatient pharmacy costs in separate regression models with the same independent variables.

Skewed distribution, heteroscedasticity, and retransformation problems in health care expenditure models have been well recognized by health services researchers (Duan 1983; Manning 1998; Manning and Mullahy 2001). We examined three models: (1) an OLS regression with robust error estimation and raw costs as the dependent variable, (2) a semilog regression where costs were transformed by a natural logarithm function and retransformed with the smearing estimator (Duan 1983), and (3) a generalized linear model (GLM) with gamma distribution and natural logarithm as the link function. The functional form of the GLM model was identified using the modified Park test recommended by Manning and Mullahy (2001). The results, however, showed that both the smearing semilog and the GLM models predicted substantially worse than the OLS model in mean costs for each of the chosen chronic diseases. The modeling analysis suggested that a model of exponential form, either indirectly through a semilog transformation or directly through a GLM modeling with logarithmic link, did not fit these data appropriately. One possible reason was that an exponential function reflected multiplicative impact of a chronic condition on costs. As discussed by Ray et al (2000), there was no compelling theoretical reason why the cost impact of having a chronic disease should be multiplicative rather than additive. Also, except for age, all of the independent variables were dichotomous, which might be inappropriate to fit into an exponential model. Therefore, we used the OLS model with robust error estimation to examine costs attributable to each chronic condition.

## RESULTS

### SAMPLE CHARACTERISTICS

For FY1999, 3,403,757 people used the VA health care system. The average age of this population was 58 years and 90 percent were male. Three percent of this population died within the fiscal year. Death rates were substantially

above this VA average for patients with lung cancer (34 percent), renal failure (18 percent), Alzheimer's disease (17 percent), dementia (15 percent), and congestive heart failure (13 percent). Forty percent of all patients were single (unmarried), 46 percent were in the VA's low-income category, and 35 percent had a service-related disability, indicating reduced copayments for care. Among the 3.4 million patients, 11 percent were African American and 4 percent were Hispanic, according to the medical records.

The regression sample had 599,975 persons. Because we excluded patients who did not have any records in the previous year, the total average cost was slightly higher in the regression sample ($4,937 vs. $4,381). The sample contains a higher proportion of veterans with service-related disabilities than the entire population (41 percent vs. 35 percent). The average age of the regression sample was 59 years and 91 percent of them were male. Other demographics were similar for the regression sample and the entire study population.

## PREVALENCE AND COSTS

The number of patients with chronic conditions and their health care costs are summarized in Table 1. Among the 3.4 million VA patients, 72 percent (2.45 million) had one or more conditions, and 35 percent had three or more. Excluding costs of contract medical services provided at non-VA facilities, VA health care expenditures totaled $14.3 billion in FY1999. The 72 percent of patients with common chronic diseases accounted for 96 percent ($13.7 billion) of these total expenditures. Furthermore, the 1.2 million patients with three or more chronic conditions were intensive users of the VA health care system, accounting for 73 percent of the total cost.

Prevalence of chronic conditions and unadjusted average annual costs per person are tabulated for each of the 29 condition groups in Table 2. The unadjusted cost is the total health care cost for people who have that chronic condition, including costs of treating other medical conditions. The most common chronic disease was hypertension, which was present in nearly 1.3 million people, or 37 percent of VA patients in FY1999. The most expensive conditions were the result of spinal cord injury ($26,735 per person per year) and renal failure ($22,656 per person per year), but the patterns of resource use differ between the two conditions. Medical/surgical hospitalizations accounted for most of the costs for renal failure patients, whereas long-term care hospitalizations accounted for most of the costs for spinal cord injury patients.

TABLE 2 Common Chronic Conditions among Veterans Affairs (VA) Patients: Age, Gender, Mortality, and Average Annual Cost per Patient in Fiscal Year 1999

| *Chronic Condition* | *Persons with Condition* | *% of Total Population* | *Mean Age* | *% Male* | *% Deaths* | *Average Cost ($)* | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | *Total* | *Medical/ Surgical* | *Other Inpatient* | *Out-patient* | *Out-patient Pharmacy* |
| Acid-related disorders | 169,721 | 5.00 | 62 | 95.90 | 4.00 | 9,046 | | 1,577 | 2,783 | 940 |
| AIDS/HIV | 18,364 | 0.50 | 46 | 97.50 | 5.20 | 12,325 | 4,202 | 1,942 | 3,292 | 2,889 |
| Alcoholism | 210,469 | 6.20 | 51 | 97.30 | 3.40 | 11,551 | 3,131 | 4,425 | 3,406 | 590 |
| Alzheimer's Disease | 20,042 | 0.60 | 76 | 96.00 | 16.60 | 19,309 | 4,671 | 11,661 | 2,286 | 690 |
| Arthritis | 549,603 | 16.10 | 62 | 95.20 | 2.30 | 6,075 | 1,890 | 1,073 | 2,364 | 748 |
| Asthma | 85,278 | 2.50 | 57 | 88.70 | 2.50 | 6,881 | 2,393 | 1,055 | 2,531 | 902 |
| Benign prostatic hyperplasia | 307,160 | 9.00 | 69 | 99.90 | 3.20 | 6,910 | 2,533 | 1,124 | 2,455 | 799 |
| Cancer (all other causes) | 74,050 | 2.20 | 64 | 93.40 | 12.30 | 12,131 | 6,638 | 1,984 | 3,510 | 1,093 |
| Cerebrovascular disease/stroke | 72,793 | 2.10 | 68 | 97.70 | 8.90 | 14,482 | 6,838 | 3,184 | 3,440 | 1,020 |
| Colorectal cancer | 24,997 | 0.70 | 69 | 97.60 | 10.70 | 13,811 | 7,525 | 1,339 | 3,908 | 1,039 |
| Congestive heart failure | 161,171 | 4.70 | 70 | 98.10 | 12.60 | 15,050 | 8,292 | 2,356 | 3,267 | 1,135 |
| Chronic obstructive pulmonary disorder | 318,861 | 9.40 | 67 | 97.90 | 8.60 | 10,618 | 4,858 | 2,281 | 2,587 | 891 |
| Dementia | 35,692 | 1.00 | 73 | 97.00 | 14.80 | 19,522 | 6,072 | 9,412 | 3,195 | 843 |
| Depression | 235,852 | 6.90 | 54 | 89.90 | 2.00 | 8,657 | 1,784 | 2,373 | 3,481 | 1,019 |

*(continued)*

TABLE 2 (continued)

| Chronic Condition | Persons with Condition | % of Total Population | Mean Age | % Male | % Deaths | Average Cost ($) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Total | Medical/ Surgical | Other Inpatient | Out-patient | Out-patient Pharmacy |
| Diabetes | 532,926 | 15.60 | 64 | 97.40 | 4.60 | 7,846 | 2,971 | 1,440 | 2,435 | 1,000 |
| Headache | 121,456 | 3.60 | 51 | 76.00 | 1.40 | 6,557 | 1,735 | 1,145 | 2,852 | 825 |
| Hepatitis C | 38,312 | 1.10 | 49 | 96.80 | 4.60 | 12,898 | 4,184 | 3,655 | 4,041 | 1,017 |
| Hypertension | 1,256,034 | 36.80 | 64 | 96.80 | 3.40 | 6,444 | 2,402 | 1,137 | 2,140 | 765 |
| Ischemic heart disease | 560,626 | 16.40 | 67 | 98.30 | 5.40 | 8,668 | 3,977 | 1,292 | 2,499 | 899 |
| Lower back pain | 361,868 | 10.60 | 55 | 92.80 | 1.90 | 6,159 | 1,744 | 1,034 | 2,610 | 771 |
| Lung cancer | 29,637 | 0.90 | 67 | 98.00 | 33.70 | 19,196 | 11,022 | 2,491 | 4,497 | 1,186 |
| Multiple sclerosis | 11,460 | 0.30 | 54 | 88.00 | 4.40 | 12,785 | 3,169 | 5,013 | 3,050 | 1,554 |
| Parkinson's Disease | 29,972 | 0.90 | 72 | 98.30 | 9.50 | 12,225 | 3,553 | 5,207 | 2,344 | 1,121 |
| Peripheral vascular disease | 132,153 | 3.90 | 68 | 98.40 | 7.20 | 13,489 | 6,788 | 2,319 | 3,324 | 1,058 |
| Prostate cancer | 106,195 | 3.10 | 72 | 99.90 | 6.60 | 8,250 | 3,123 | 1,175 | 2,988 | 965 |
| Renal failure | 58,109 | 1.70 | 67 | 98.30 | 17.90 | 22,656 | 13,094 | 3,085 | 5,047 | 1,430 |
| Spinal cord injury | 19,855 | 0.60 | 56 | 97.00 | 6.90 | 26,735 | 5,311 | 15,864 | 3,293 | 2,267 |
| Substance abuse | | | | | | | | | | |
| Cocaine abuse | 58,426 | 1.70 | 45 | 96.50 | 1.20 | 14,163 | 1,842 | 7,008 | 4,762 | 551 |
| Stimulant abuse | 6,081 | 0.20 | 44 | 95.40 | 1.50 | 13,307 | 1,702 | 6,137 | 4,777 | 691 |
| Opiate addiction/ abuse | 27,448 | 0.80 | 47 | 96.80 | 2.40 | 15,296 | 2,696 | 5,939 | 5,892 | 769 |
| Drug dependence, nondependent abuse of drugs | 292,704 | 8.60 | 53 | 95.30 | 2.50 | 9,390 | 2,714 | 2,860 | 3,112 | 704 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Drug psychoses | 16,857 | 0.50 | 47 | 96.00 | 3.00 | 18,535 | 3,460 | 9,526 | 4,842 | 707 |
| Psychoses | | | | | | | | | | |
| Schizophrenia | 115,876 | 3.40 | 53 | 94.70 | 3.30 | 14,385 | 1,924 | 7,456 | 3,932 | 1,074 |
| Manic depressive | 71,606 | 2.10 | 51 | 89.90 | 2.10 | 12,190 | 1,768 | 5,419 | 3,993 | 1,010 |
| Post-traumatic stress disorder (PTSD) | 171,364 | 5.00 | 53 | 93.90 | 1.70 | 8,284 | 1,459 | 2,285 | 3,534 | 1,006 |
| Antisocial personality disorder | 7,004 | 0.20 | 45 | 97.70 | 1.70 | 19,304 | 2,427 | 11,267 | 4,858 | 752 |
| Borderline personality | 8,172 | 0.20 | 43 | 68.20 | 1.40 | 17,439 | 2,042 | 8,518 | 5,627 | 1,252 |
| Personality disorders | 39,299 | 1.20 | 48 | 91.20 | 1.80 | 14,701 | 1,972 | 7,202 | 4,546 | 982 |
| Paranoid states/ other nonorganic psychoses | 47,644 | 1.40 | 57 | 94.90 | 5.80 | 15,230 | 3,388 | 6,790 | 4,038 | 1,013 |
| Other psychotic conditions | 567,600 | 16.70 | 56 | 92.10 | 4.00 | 9,690 | 2,651 | 3,107 | 3,031 | 901 |

## ATTRIBUTABLE COSTS

Health care costs attributed to each condition were analyzed through regression models. Since all independent variables in the regression models are expressed in deviations from their respective means, the intercepts are exactly equal to the sample means. For example, the intercept in the total cost model is $4,947, which is the average cost of the sample. Therefore, the reference group of the regression is the sample average. If the coefficient of a disease (e.g., asthma) is not statistically significant, it means that having the disease (e.g., asthma) does not add extra cost to the sample average. Furthermore, the age-condition interaction terms are all equal to zero when age is equal to the sample mean.

Regression coefficients from the four OLS models reflect marginal costs from the sample mean (see Table 3). For the total cost model, 24 of the 29 conditions show positive coefficients that are statistically significant at the 1 percent or 5 percent level, indicating significant health care costs attributed to these conditions. For example, the marginal total annual cost is $23,000 for renal disease, $11,000 for dementia, and $5,000 for Alzheimer's disease. The marginal total cost from hypertension, however, is only $600.

Coefficients in the cost component models reflect the marginal impact of each health condition on total, inpatient, outpatient, and outpatient pharmacy costs, respectively. Comparison of coefficients across cost component models provides patterns of marginal cost impacts among chronic conditions. For example, the coefficient in the total cost model for patients with AIDs/HIV is 2,071 and not statistically significant (see Table 3). However, the coefficient for AIDs/HIV patients in the pharmacy cost model is 2,369 and significant at the 1 percent level. These coefficients suggest that patients with AIDs/HIV cost $2,369 more in pharmacy clinics than the sample average, but their inpatient and outpatient costs are similar to the average.

Similarly, for asthma and benign prostatic hyperplasia, marginal outpatient and pharmacy costs are positive and significant at the 1 percent level. For psychoses, the marginal impact on total cost is negative and statistically insignificant. The marginal impacts of psychoses, however, in the cost components models are all significant, but in opposite direction: negative for inpatient costs, and positive for outpatient and pharmacy. This suggests that the increase in outpatient and pharmacy costs from psychoses cancels out the decrease in inpatient costs, making the net impact on total cost statistically insignificant. The estimated coefficient and standard error for Alzheimer's disease suggest that this disease group has a lot of variation. Only the outpatient pharmacy cost shows significant marginal impact.

TABLE 3 Regression Model of Total Annual Costs, Inpatient Costs, Outpatient Costs, and Pharmacy Costs ($N$ = 599,975)

| | *Total Cost* | | *Inpatient Cost* | | *Outpatient Cost* | | *Outpatient Pharmacy Cost* | |
|---|---|---|---|---|---|---|---|---|
| *Chronic Condition* | $R^2$ = *0.19* | SE | $R^2$ = *0.12* | SE | $R^2$ = *0.23* | SE | $R^2$ = *0.13* | SE |
| Acid-related disorders | 2,099** | 424 | 1,085** | 403 | 714** | 92 | 300** | 38 |
| AIDS/HIV | 2,071 | 1,460 | 86 | 1,385 | –283 | 332 | 2,269** | 227 |
| Alzheimer's Disease | 4,947 | 3,517 | 3,764 | 3,441 | 525 | 663 | 658* | 281 |
| Arthritis | 1,241** | 172 | 572** | 159 | 591** | 44 | 78** | 18 |
| Asthma | 55 | 365 | –347 | 339 | 27** | 91 | 124** | 40 |
| Benign prostatic hyperplasia | 461 | 386 | –698 | 357 | 818** | 105 | 341** | 42 |
| All other cancers | 9,670** | 904 | 5,977** | 849 | 2,983** | 201 | 710** | 83 |
| Colorectal cancer | 12,023** | 1,836 | 7,218** | 1,673 | 3,813** | 438 | 992** | 184 |
| Lung cancer | 29,594** | 2,481 | 22,512** | 2,383 | 5,489** | 480 | 1,592** | 212 |
| Cerebrovascular disease | 3,406** | 1,075 | 2,255* | 1,037 | 972** | 224 | 179* | 88 |
| Congestive heart failure | 8,340** | 900 | 6,852** | 861 | 963** | 192 | 525** | 68 |
| Chronic obstructive pulmonary disorder | 1,051* | 457 | 204 | 437 | 475** | 95 | 372** | 39 |
| Dementia | 10,969** | 2,225 | 8,629** | 2,200 | 1,919** | 436 | 422** | 159 |
| Depression | 4,239** | 321 | 3,770** | 298 | 584** | 87 | –115** | 33 |
| Diabetes | 2,564** | 261 | 922** | 246 | 891** | 65 | 751** | 29 |
| Headache | 1,013** | 276 | 824** | 251 | 166* | 77 | 23 | 34 |
| Hepatitis C | 3,837** | 1,220 | 2,852* | 1,153 | 722* | 323 | 263* | 115 |
| Hypertension | 626** | 155 | 147 | 146 | 278** | 39 | 201** | 16 |
| Ischemic heart disease | 4,942** | 318 | 3,036** | 299 | 1,520** | 78 | 386** | 31 |
| Lower back pain | 935** | 170 | 653** | 156 | 227** | 50 | 56** | 20 |
| Multiple sclerosis | 4,321** | 1,626 | 1,882 | 1,566 | 529 | 322 | 1,910** | 213 |
| Parkinson's Disease | 9,170** | 2,542 | 4,989* | 2,462 | 3,199** | 583 | 981** | 186 |

*(continued)*

TABLE 3 (continued)

| Chronic Condition | *Total Cost* $R^2$ = *0.19* | SE | *Inpatient Cost* $R^2$ = *0.12* | SE | *Outpatient Cost* $R^2$ = *0.23* | SE | *Outpatient Pharmacy Cost* $R^2$ = *0.13* | SE |
|---|---|---|---|---|---|---|---|---|
| Peripheral vascular disease | 9,268** | 919 | 6,997** | 880 | 1,669** | 204 | 602** | 74 |
| Prostate cancer | 6,121** | 865 | 2,249** | 780 | 3,472** | 300 | 401** | 96 |
| Renal failure | 22,836** | 1,662 | 12,309** | 1,507 | 8,676** | 646 | 1,850** | 130 |
| Spinal cord injury | 8,331** | 2,192 | 5,990** | 2,177 | 346 | 303 | 1,995** | 190 |
| Alcoholism | 3,124** | 452 | 1,769** | 431 | 1,540** | 106 | –186** | 33 |
| Substance abuse | 5,534** | 304 | 3,496** | 287 | 1,874** | 71 | 163** | 28 |
| Psychoses | –132 | 233 | –1,870** | 225 | 1,105** | 50 | 633** | 21 |
| Age*Acid-related disorders | 7 | 3 | 7 | 7 | –3* | 1 | –2* | 1 |
| Age*AIDS/HIV | 71* | 33 | 46 | 31 | 30** | 8 | –5 | 5 |
| Age*Alzheimer's Disease | –19 | 46 | –3 | 45 | –7 | 9 | –9* | 4 |
| Age*Arthritis | –13** | 3 | –10** | 3 | –3** | 1 | 0 | 0 |
| Age*Asthma | 35** | 7 | 26** | 6 | 7** | 2 | 3** | 1 |
| Age*Benign prostatic hyperplasia | 4 | 6 | 12* | 5 | –4** | 1 | –3** | 1 |
| Age*All other cancers | –45** | 14 | –19 | 13 | –20** | 3 | –6** | 1 |
| Age*Colorectal cancer | –80** | 26 | –40 | 24 | –30** | 6 | –10** | 3 |
| Age*Lung cancer | –265** | 36 | –201** | 34 | –46** | 7 | –18** | 3 |
| Age*Cerebrovascular disease | 29 | 16 | 29 | 15 | 0 | 3 | 0 | 1 |
| Age*Congestive heart failure | –30* | 13 | –23 | 12 | –2 | 3 | –4** | 1 |
| Age*Chronic obstructive pulmonary disorder | 27** | 7 | 32** | 7 | –2 | 1 | –3** | 1 |
| Age*Dementia | –72* | 30 | –48 | 30 | –18** | 6 | –6** | 2 |
| Age*Depression | –89** | 6 | –94** | 6 | 1 | 2 | 5** | 1 |
| Age*Diabetes | –12** | 4 | –2 | 4 | –5** | 1 | –6** | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Age*Headache | –5 | 5 | –18** | 5 | 10** | 2 | 3** | 1 |
| Age*Hepatitis C | 7 | 25 | –1 | 24 | 10 | 6 | –1 | 2 |
| Age*Hypertension | –3 | 3 | –3 | 2 | 0 | 1 | –1** | 0 |
| Age*Ischemic heart disease | –43** | 5 | –25** | 5 | –15** | 1 | –3** | 0 |
| Age*Lower back pain | –8* | 3 | –16** | 3 | 7** | 1 | 2** | 0 |
| Age*Multiple sclerosis | –18 | 31 | –5 | 30 | 11 | 6 | –23** | 4 |
| Age*Parkinson's Disease | –71* | 35 | –27 | 34 | –37** | 8 | –7** | 3 |
| Age*Peripheral vascular disease | –63** | 13 | –46** | 13 | –11** | 3 | –6** | 1 |
| Age*Prostate cancer | –54** | 12 | –21 | 11 | –31** | 4 | –1 | 1 |
| Age*Renal failure | –151** | 24 | –38 | 22 | –92** | 9 | –21** | 2 |
| Age*Spinal cord injury | 154** | 40 | 145** | 40 | 20** | 6 | –12** | 3 |
| Age*Alcoholism | 28** | 9 | 37** | 9 | –11** | 2 | 1* | 1 |
| Age*Substance abuse | –64** | 6 | –41** | 5 | –22** | 1 | –2** | 0 |
| Age*Psychoses | 66** | 4 | 74** | 4 | –3** | 1 | –6** | 0 |
| Demographic information | | | | | | | | |
| Marital status: Unmarried | 1,203** | 35 | 1,022** | 33 | 196** | 8 | –15** | 3 |
| African American | 1,902** | 60 | 1,496** | 57 | 432** | 15 | –27** | 5 |
| Hispanic | 540** | 80 | 304** | 76 | 216** | 21 | 20* | 8 |
| Service-connected disability | 646** | 41 | –4 | 38 | 509** | 10 | 142** | 4 |
| Low–income | 185** | 42 | –120** | 39 | 227** | 10 | 79** | 4 |
| Age | 6** | 1 | 2 | 1 | 2** | 0 | 3** | 0 |
| Female | 605** | 44 | 350** | 41 | 240** | 11 | 15** | 5 |
| Constant | 4,947** | 16 | 2,574** | 15 | 1,785** | 4 | 588** | 2 |

*$p < .05$. **$p < .01$.

All social-demographic variables are positive and significant at the 1 percent level. Age has two effects on costs. While costs increase with age in general (the age coefficient of six), age affects costs in different directions for specific medical conditions. For lung cancer, for example, the total cost increases with age by $6 per year above the average age (59 years), and the age-cancer interaction reduces total cost by $265 per year above the average age. The net effect suggests that older patients with lung cancer receive progressively less aggressive treatments.

## DISCUSSION

VA data for FY1999 indicate that 72 percent of the VA patients have at least one of the 29 chronic diseases and more than one-third have three or more chronic conditions. The prevalence of chronic conditions in VA is much higher than in the general U.S. population. Based on 1987 National Medical Expenditure Survey, Hoffman, Rice, and Sung (1996) show that 47 percent of Americans who have used medical care for their health conditions have one or more chronic conditions. Two recent studies based on managed care populations show that nearly 40 percent of the enrollees have a common chronic illness (Fishman et al. 1997; Ray et al. 2000).

Because the denominators of the two managed care studies included people who do not use any medical care in the study period, adjustments should be made before the comparison to reflect the number of people who do not use any medical care in a year. A study by Ash et al. (2000) showed that 16 percent of Medicare enrollees and 40 percent of the working population (younger than age 65) use no care in a given year. Since both managed care plans contain young and old enrollees, if we assume that 35 percent use no care, the prevalence of chronic conditions among people who used any medical care for the two studies would be approximately 60 percent.

This is much lower than the 72 percent prevalence that we observed among VA patients. The high prevalence among VA patients is probably due to two major factors. First, VA eligibility policy gives high priority to veterans who are either disabled from their military service or live in poverty. Second, veterans are older than the general population and the elderly are more likely to be infirm.

Another important finding is that the 72 percent of patients who had one or more of the 29 chronic conditions accounted for 96.5 percent of total VA health care costs. The 1987 National Medical Expenditure Survey study shows that the 46 percent of people with one or more chronic conditions accounted for 76 percent of total health care costs (Hoffman, Rice, and Sung 1996). People with chronic conditions in the studies by Fishman et al. (1997) and Ray et al. (2000)

accounted for 71 percent and 78 percent of total costs, respectively. It appears that patients without chronic diseases incurred fewer costs in the VA health care system than they did in non-VA health care systems. These patients may be healthier than those observed in non-VA populations, or they may use another insurance plan, such as Medicare, as their primary coverage and the VA as supplement insurance (Wright, Hossain, and Petersen 2000; Wright, Lamkin, and Petersen 2000).

As an integrated health care system with salaried physicians and staff, the VA is more comparable with a staffed managed care organization, such as Kaiser Permanente. The prevalence of chronic diseases in VA is similar to the Kaiser Permanente and Group Health Cooperative studies. The top five chronic conditions among the VA patients are hypertension (37 percent), psychoses (26 percent), ischemic heart disease (16 percent), arthritis (16 percent), and diabetes (16 percent). The top five chronic conditions for Group Health Cooperative population were back and neck pain, heart disease, hypertension, diabetes, and arthritis (Hoffman, Rice, and Sung 1996). In the Kaiser Permanente study, the top five were hypertension, low back pain, benign conditions of the uterus, asthma, and diabetes (Ray et al. 2000).

VA is one of the largest providers of specialty mental health care in the United States. The large number of patients provides a unique opportunity to look at the costs for mental health conditions. For the substance abuse subgroup, patients with nondependent abuse of drugs cost less than the other subgroups (see Table 2), due primarily to lower inpatient substance abuse treatment and lower outpatient cost. Similarly, for mental health conditions, costs for patients with post-traumatic stress disorder (PTSD) and other psychotic conditions were much lower than the other six subgroups.

It should be noted that a substantial number of VA patients are also eligible for Medicare or Medicaid insurance (Shen et al. 2003). Therefore, costs measured in this study are less than the costs for all health care received by these patients. This is likely to vary by condition. For instance, spinal cord injury may be more complete as there are fewer non-VA specialty providers of this care. Yet to understand the cost of chronic illness, it is critically important to combine these data with information from other providers, such as Medicare and Medicaid.

Another limitation is that the regression models do not control for all medical conditions. It is very likely that some medical conditions, such as urinary incontinence, are associated with the 29 chronic conditions. Hence, the marginal costs reflected by the coefficients in the regression model may include some cost impact from those other unobserved medical conditions. However, if a chronic condition increases the probability of having some other medical

conditions, the coefficients estimated in our regression models can also be considered a broadly defined marginal cost of having one chronic condition.

For some services, particularly long-term care, VA contracts with non-VA providers. We do not have detailed information on costs and utilization for contracted services, so these costs are not included in this study. For FY2000, contracted services accounted for about 7 percent of total VA health care cost. The impact of contracted services on our estimates may not be evenly distributed among the 29 chronic conditions, depending on the proportion of each type of care that was contracted for a specific condition.

This is the first study to provide a comprehensive profile of the prevalence and annual costs of common chronic conditions among VA patients. This study shows that veterans who used the VA health care system have a higher prevalence of chronic conditions than the general population. The results may be used by providers, policy makers, and social scientists to set research priorities and guide resource allocation debates. Yet these results also show that management decisions based on information from the general population may not be easily extrapolated to the VA population. Because the VA health care system is an integrated system that provides comprehensive coverage, information from this VA study may provide a more complete pattern of resource use for certain medical conditions. For example, VA provides special treatment programs for substance abuse, and our study suggests that more than 60 percent of marginal costs due to substance abuse are from inpatient care.

As 72 percent of VA patients had one or more of the 29 common chronic conditions and their health care utilization accounted for 96 percent of VA costs, the results in this article provide a comprehensive background in health care resource use for many VA health care and health services studies. Although the cost estimates are specific for FY1999, the type and proportion of resources used for each chronic condition should be relatively stable. The fact that a substantial number of VA patients have multiple chronic diseases raises questions about effective care and efficient use of health care resources for VA patients. As an integrated health care system, the VA has an advantage in providing integrated care for such patients. Future studies are needed to understand and guide the services provided to patients with chronic conditions.

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# Glossary

AAC — Austin Automation Center
The AAC is a federal data center. All Veterans Affairs (VA) data including the National Patient Care Database and Decision Support System (DSS) National Data Extracts are housed at AAC.

ACRS — Automated Customer Registration System
Researchers interested in accessing the VA DSS data must first get permission from ACRS. This permission is then recorded and automatically checked each time access is requested.

APC — Ambulatory Payment Classifications
The Centers for Medicare and Medicaid Services (CMS) was mandated through the Omnibus Budget Reconciliation Act of 1986 to develop a prospective payment system (PPS) for outpatient services. All services paid under the new PPS are classified into groups called Ambulatory Payment Classifications or APCs. Services in each APC are similar clinically and in terms of the resources they require. A payment rate is established for each APC. Depending on the services provided, hospitals may be paid for more than one APC for an encounter.

AWP — Average Wholesale Price
AWPs are a set of wholesale prices for pharmaceuticals. A common source of AWP information is *The Red Book* (see http://www.medec.com/html/products/productdetail/redbook.html).

BID — *bis in die*
This is a Latin term that means giving medication twice a day.

BIRLS — Beneficiary Information and Records Locator Subsystem
BIRLS is a set of databases that can be linked by social security number. With BIRLS, a researcher can gain information on veterans who died and obtained benefits from VA (for mortality studies), who received a monetary benefit for aid and attendance (to defray, perhaps, the cost of the Community Residential Care Program), who had accounts for VA educational benefits (to determine the extent of contact with VA for other services besides health care), type and amount of benefits paid to com-

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pensation and pension recipients (a rich source for sampling veterans), as well as many other issues.

BPA — Blanket Purchase Agreement
BPA allows individual VA facilities to obtain additional discounts for particular medications. BPAs are negotiated with commitment volumes/quantities in mind, in exchange for additional price consideration, as well as additional value-added programs and services. Many agreements are negotiated for specific customer groups under the VA Federal Supply Schedule program, depending on tracking requirements and interest within the customer group.

CAC — Cost Adjusted Charges
Charges are often obtained from hospital bills or from discharge data. Charges are frequently higher than actual costs. We can adjust the charges to reflect the actual amount of resources used by multiplying reported charges by a hospital-level cost-to-charge ratio. We refer to the adjusted charges as CAC.

CCS — Clinical Classifications Software
CCS is a tool for clustering patient diagnoses and procedures into clinically meaningful categories. This software was developed by the Agency for Healthcare Quality and Research (see http://www.ahrq.gov/data/hcup/ccs.htm).

CDA — Cost Distribution Account
The VA Cost Distribution Report includes patient care departments such as medicine, admitting and screening, or ambulatory surgery. It also includes services related to indirect costs such as building management. Expenditures for these departments are listed in CDAs.

CDR — Cost Distribution Report
The CDR is routinely prepared by all VA medical centers. The CDR represents an estimate of the costs expended by each VA patient care department. The data in the CDR come from the Financial Management System.

CMOPs — Consolidated Mail Outpatient Pharmacies
The VA has seven mail-order distribution centers for pharmaceuticals known as CMOPs.

CMS — Centers for Medicare and Medicaid Services (formerly Health Care Financing Agency)
CMS is the federal agency within the U.S. Department of Health and Human Services that runs the Medicare and Medicaid programs. CMS works to make sure that the beneficiaries in these programs are able to get high-quality health care (see www.cms.gov).

COPD Chronic Obstructive Pulmonary Disease
COPD is composed primarily of two related diseases: chronic bronchitis and emphysema. In both diseases, the flow of air through the airways and out of the lungs is obstructed. The condition is permanent and worsens over time.

CPI Consumer Price Index
CPI comprises data on changes in the prices paid by consumers for a representative basket of goods and services.

CPRS Computerized Patient Record System
CPRS is one component of the larger clinical and management information system known as the Veterans Health Information Systems and Technology Architecture (VISTA).

CPT Current Procedural Terminology
CPT codes were developed by the American Medical Association in 1966. Each year, an updated publication is prepared to reflect updates in medical technology and practice. The 2002 version of CPT contained 8,107 codes and descriptors. VA uses CPT codes to identify ambulatory care procedures.

CSP Cooperative Studies Program
CSP encourages and supports VA investigators to conduct clinical research and data collection across selected research facilities. CSP conducts multicenter studies to provide a natural resource to the VA health care community and beyond.

DAP Drug Accountability Package
DAP is software that is part of VISTA, and it is responsible for tracking current drug costs.

DRG Diagnostic Related Group
DRG is a classification system for inpatient care. DRG assignment is based on six factors: (1) principal diagnosis, (2) secondary diagnosis, (3) surgical factors, (4) age, (5) sex, and (6) discharge status. Under the PPS, hospitals are paid a set fee for treating patients in a single DRG category, regardless of the actual cost of care for the individual.

DSS Decision Support System
DSS is a set of programs that use relational databases to provide information needed by managers and clinicians, including the cost of specific patient care encounters.

E&M Evaluation and Management
E&M is a set of CPT codes that refer to evaluation and management services.

FCP Federal Ceiling Price
This is a federal price schedule for pharmaceuticals available to the Big 4: VA, the Department of Defense, the Coast Guard, and the Public Health Services.

FMS Financial Management System
FMS tracks VA expenditures by "cost center." VA expenditures are recorded in a general ledger—an accounting entity that corresponds to a VA service.

FSS Federal Supply Schedule
FSS is a multiple-award, multiyear federal contract that is available for use by any federal government agency. It satisfies all federal contract laws. Pricing is negotiated based on how vendors do business with their commercial customers. The FSS program also provides additional opportunities for savings to the customers with negotiated quantity and tier discounts.

FY Fiscal Year
The federal FY begins on October 1 and ends on September 30 of the following year. The convention is to refer to a federal FY by the year it ends; thus, FY 98 represents the period 1 October 1997 to 30 September 1998.

GHC Group Health Cooperative
GHC is a nonprofit HMO that provides both care and coverage. It is a staff-model HMO as physicians are salaried employees.

GLM Generalized Linear Model
GLMs are a large class of statistical models for relating responses to linear combinations of predictor variables. Models for continuous variable, rates, and proportions; binary, ordinal, and multinomial variables; and counts can be handled as GLMs. GLMs can also handle different error structures.

HCFA Health Care Financing Agency (now CMS)
As of 1 July 2001, HCFA was renamed CMS.

HCPCS Health Care Financing Administration's Common Procedure Coding System
This system was developed to cover medical supplies, devices, and specialized services not represented by CPT codes.

HCUP Healthcare Cost and Utilization Project
HCUP is a family of health care databases and related software. HCUP databases bring together the data collection efforts of state data organizations, hospital associations, private data organizations, and the federal government to create a national information resource of patient-level health care data.

HERC Health Economics Resource Center
HERC is a national center that assists VA researchers in assessing the cost effectiveness of medical care, evaluating the efficiency of VA programs and providers, and conducting high-quality health economics research.

HSR&D Health Services Research and Development Service
This is one of the four research services within the VA Office of Research and Development.

ICU Intensive Care Unit
ICUs provide more intensive care to more severely ill patients. Accordingly, ICUs have greater personnel and facility costs. There are different types of ICUs (e.g., medical, coronary, surgical), but often the term *ICU* is used to refer to any of these categories.

IRB Institutional Review Board
IRBs review research protocols that involve human participants. They ensure the ethical and safe treatment of study participants.

IRM Information Resource Management
This is the service at each VA medical center that supports the local information technology and computer networks.

IV Intravenous
This is one of the common drug delivery methods (the other is oral). This involves administering the medication into a vein.

JCAHO Joint Commission on Accreditation of Healthcare Organizations
VA hospitals seek JCAHO accreditation. JCAHO's mission is to continuously improve the safety and quality of care provided to the public through the provision of health care accreditation and related services that support performance improvement in health care organizations.

KP Kaiser Permanente
KP is America's largest not-for-profit HMO. KP is composed of two organizations: the health maintenance organization and the Permanente physician group. KP is referred to as a group-model HMO.

LOS Length of Stay
This is the length, measured in number of days, of an inpatient hospital stay.

MAC Maximum Allowable Cost
MAC is a ceiling price for health care services such as medicines.

MDC Major Diagnostic Category
The MDC is a classification system that represents groups of similar DRGs. Each MDC typically involves the same organ system of the body.

MEDPAR Medicare Provider Analysis Review File
The MEDPAR is a hospital discharge database containing records for Medicare beneficiaries who were discharged in a given year. The MEDPAR database is created by CMS.

MEPS Medical Expenditure Panel Survey
The MEPS is the third (and most recent) in a series of national probability surveys conducted by the Agency for Healthcare Research and Quality on the financing and use of medical care in the United States (see http://www.meps.ahrq.gov).

MUMPS Massachusetts General Hospital Utility Multiprogramming System
This is software developed for the lab system at Massachusetts General in 1966. VISTA is based on MUMPS. The four rules of MUMPS are (1) thou shalt not declare variable types or file sizes; (2) thou shalt not KILL, except for globals and variables; (3) thou shalt not covet thy neighbor's User Class Identifiers (UCI); and (4) remember string handling, for it shall make MUMPS special.

NCHS National Center for Health Statistics
NCHS, a division of the Centers for Disease Control, gathers and stores statistical data on health. It is responsible for several large-scale national health surveys.

NDC National Drug Code
The NDC serves as a universal product identifier for human drugs.

NDE National Data Extract
The NDE is a set of data sets generated from the VA DSS.

NPCD National Patient Care Database
NPCD is the integration of four existing Veterans Health Administration (VHA) databases into a single, patient-centric database. It is composed of the Patient Treatment File, Outpatient Care File, Integrated Patient Database (IPDB), and Event Driven Reporting (EDR) databases.

OLS Ordinary Least Square
This is the most common regression technique, and it uses least squares as the fitting criterion. Thus, OLS minimizes the sum of squared residuals, and the beta coefficients are the values at which this is achieved.

OPC Outpatient Care File
The OPC is an automated system for recording and tracking events associated with each VA patient's outpatient clinical progress. The OPC file is the principal source of outpatient workload data.

PBM/SHG Pharmacy Benefits Management Strategic Healthcare Group
PBM/SHG is composed of clinical pharmacists, data analysts, and administrative pharmacy personnel. PBM is partly responsible for facili-

tating and coordinating the VA national formulary process (see http://www.vapbm.org/PBM/menu.asp).

PRRTP Psychosocial Residential Rehabilitation Treatment Program
PRRTP is designed to provide a therapeutic residential environment often necessary to sustain outpatient treatment for psychiatric conditions and psychosocial readjustment. VA defines PRRTP as inpatient care, and it is often viewed as an alternative to specialty psychiatry and substance abuse inpatient care.

PTF Patient Treatment Files
PTF is the principal source of inpatient workload data. The database contains abstracts of each VA patient's clinical care.

PTSD Post-Traumatic Stress Disorder
PTSD is a psychiatric disorder that can occur following the experience or witnessing of life-threatening events such as military combat, natural disasters, and so forth.

QUERI Quality Enhancement Research Initiative
The QUERI is mandated to translate research discoveries and innovations into better patient care of our nation's veterans and VA systems improvement.

RBRVS Medicare Resource Based Relative Value Scale
RBRVS values are weights that are based on the time it takes to provide a service or to perform a procedure. They also reflect the minimum training required to provide a given service; this compensates providers for income lost during their years of training.

RUG Resource Utilization Group
RUG is a validated instrument to measure nursing home residents' resource use. There are two primary versions: RUG II and RUG III.

RVU Relative Value Unit
An RVU is a weight (e.g., RBRVS) that provides information on relative resource use.

SE VA Outpatient Event File
SE refers to the VA Outpatient Event File SE version. It is a VA database for outpatient care.

SMI Serious Mental Illness
SMI is defined as a condition affecting people age 18 and older who currently or at any time during the past year have had a diagnosable mental, behavioral, or emotional disorder of sufficient duration to meet diagnostic criteria specified within the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.) that has resulted in functional impairment that substantially interferes with or limits one or more major life activities.

SSN — Social Security Number
The nine-digit SSN is divided into three parts. The first three digits are the area number. If your number was assigned before 1972 when social security cards were issued by local offices, the area number reflects the state where you applied for your number. If your number was assigned in 1972 or later, the area number reflects the state as determined by the ZIP code in the mailing address on your application for the number. The middle two digits are the group number. They have no special geographic or data significance but merely serve to break the number into conveniently sized blocks for orderly issuance. The last four digits are serial numbers. They represent a straight numerical sequence of digits from 0001 to 9999 within the group.

TID — *ter in die*
This is a Latin phrase that means giving medication three times per day.

UD — Unit Dose
Medications are often based on a UD order. The provider specifies the dosage, route, and schedule on the prescription.

VA — Department of Veterans Affairs
VA has three main functions: to assist veterans in burial costs, to provide eligible veterans with medical care, and to provide eligible veterans with compensation/pension services. Among health researchers, VA is often used interchangeably with VHA.

VHA — Veterans Health Administration
VHA is responsible for providing medical care to eligible veterans.

VISN — Veterans Integrated Service Network
This is a geographically identified network of VA medical centers. The VA medical system consists of 22 VISNs that are focused on pooling and aligning resources to better meet local health care needs and to provide greater access to care.

VISTA — Veterans Health Information Systems and Technology Architecture
VISTA is an automated environment that supports day-to-day operation at local VA health care facilities.

WAC — Wholesale Acquisition Cost
WAC is a pricing term meant to approximate what a drug wholesaler pays a manufacturer for a drug. A pharmacy's actual cost would presumably be slightly higher, since it would have to pay the wholesaler a markup.